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The MENTOR

SEPTEMBER 1925

"MEN ARE SQUARE." From a painting by Gerrit A. Beneker — *See Page 44*

BENEKER—PAINTER OF MEN AT WORK

UNCLE SAM'S OLD CURIOSITY SHOP

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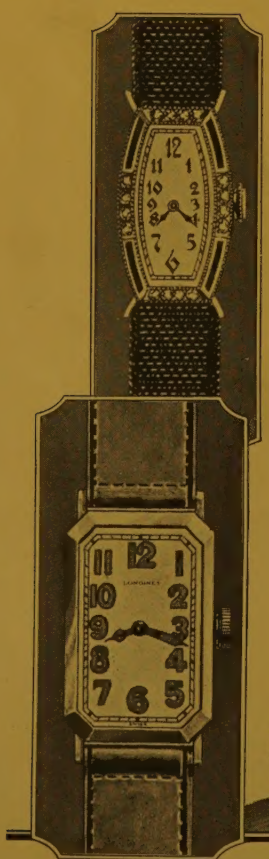

Official Government Observatory Awards

At U. S. Naval Observatory — Washington: Longines have been first in order of merit in all trials. Since 1916 more Longines Watches passed six-months' Accuracy Trial and were accepted than those of all other competing firms combined.

At Geneva Observatory—Switzerland: This year Longines again obtained first prize of series, duplicating results of 1923 and 1924; also obtained many additional individual prizes.

At Neuchatel Observatory — Switzerland: 365 awards in Accuracy Contests, since 1905. During 1924 Longines received 17 first prizes.

At Kew Teddington Observatory—England: 132 awards in Accuracy Contests, since 1910 (1918 year's records for the best performance.) Since 1919 every Longines Watch submitted passed trial with mention "especially good."

The Longines WATCH

A. WITTNAUER CO.

Established 1866

New York Chicago Montreal Geneva

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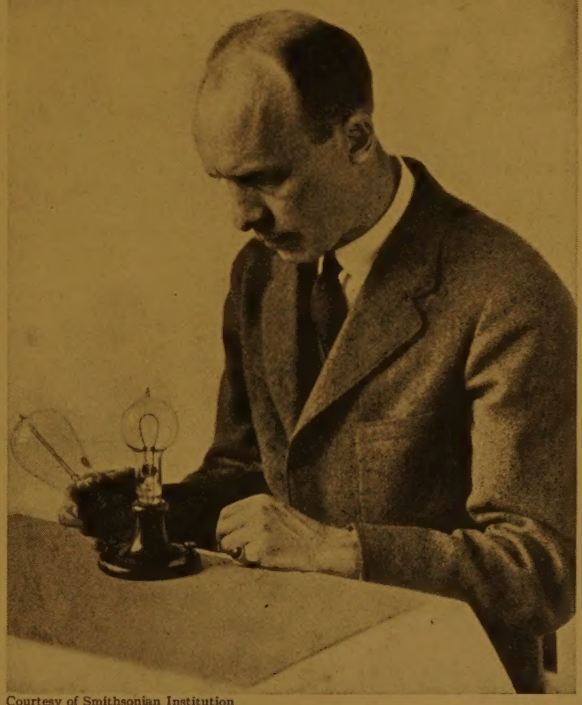
THE PASSING OF UNCLE SAM'S OLD CURIOSITY SHOP

BY DONALD MAC GREGOR



Courtesy of Smithsonian Institution

C. W. MITMAN, SMITHSONIAN INSTITUTION, WITH FIRST EDISON LAMP

Mr. Mitman is looking at a replica of the first incandescent lamp patented by Edison in 1880 and comparing it with the present-day lamp which he is holding in his hand

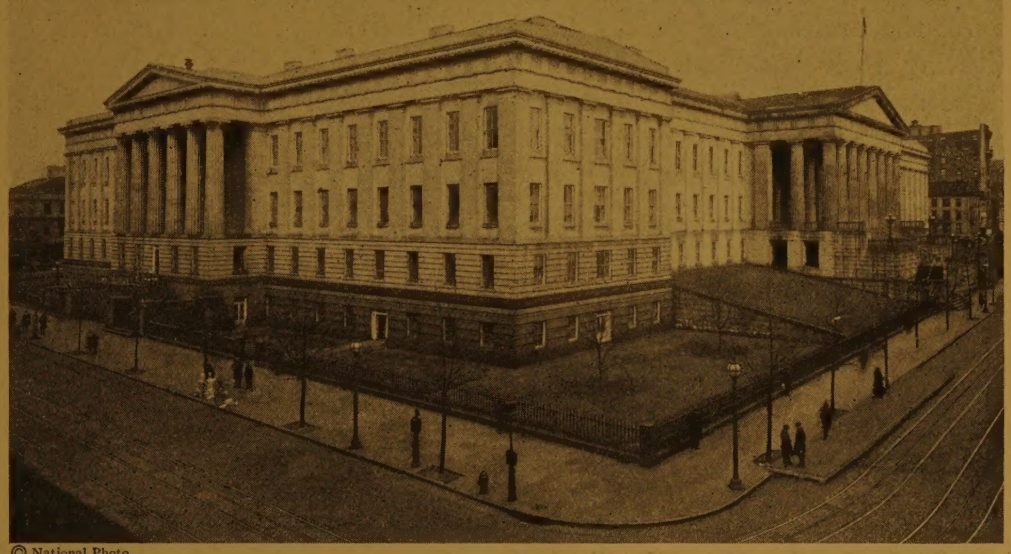
UNCLE SAM *is closing out his Old Curiosity Shop. He is taking an inventory of two centuries of human hopes—hopes in some cases realized and richly rewarded; in other cases, frustrated and forgotten. For years the Patent Office Building, in Washington, has been a national storehouse of ideas in concrete form—ideas represented by models and diagrams to the number of a million and a half; a prodigious and impressive exhibit of the vision-seeing faculty, the ingenuity and the eccentricity of mankind.*

THE COMMISSIONER OF PATENTS LOOKING THINGS OVER

Thomas E. Robertson, Patent Commissioner, inspecting a part of the collection of 155,000 patent models shortly to be dispersed by the government

THE MENTOR

Vol. 13 No. 8 ✣ SEPTEMBER, 1925 ✣ Serial No. 271



© National Photo

UNITED STATES PATENT OFFICE BUILDING, WASHINGTON, D. C.

The original, or F Street wing, designed by Robert Mills, was completed in 1840; the east wing, 1852; the west, 1856, and the north, 1867—all three the work of Thomas U. Walter and Edward Clark. In the east wing the second inaugural ball for President Lincoln was held. The architecture is pure Grecian, the F Street portico being a reproduction of the front of the Parthenon

THE PASSING OF UNCLE SAM'S OLD CURIOSITY SHOP ✣ ✣ ✣

BY DONALD MACGREGOR

Yielding to the pressure of modern business and needing more elbow room in the Patent Office, Uncle Sam is disposing of the patent models deposited there by the inventors of the country almost since the beginning of our national life. He is hauling out and carting away all the ancient machines and dusty appliances that have been milestones in our industrial development. From this time on, as in the last few years, all anybody will need as the basis for a patent claim will be a neat India ink drawing or a blueprint, later to be filed away in an up-to-date steel case.

There are, roughly, 155,000 models in the hands of the patent authorities; but even now, if you went to Washington, you would find that they are not available for public inspection. They are, instead, packed in 2,700 large boxes and crates, stored in an old livery stable for which the government

no longer wants to pay rent. If your imagination is good you can draw a vivid and vital human picture of the romance, the dreams realized and the broken hopes represented by these old relics.

Some time has passed since the businesslike Patent Office had any real use for patent models. If the Smithsonian Institution cared to preserve the more important models, that was its right.

At the Smithsonian to-day there are about five hundred models, constituting a display of some of the originals of basic and modified patents. These are to be augmented within the next few months from the store of boxes in the old livery stable—a feeble effort to keep the record and stimulate future inventors. But it will not be the same. The models will lack the picturesque setting of the Old Curiosity Shop.

Congress recently appropriated ten thousand dollars and authorized a committee of three to dig out the models and do away with them by one means or another. Some are so old that it may be impossible to determine, with any accuracy, just what they are or for what they are intended.

The Smithsonian will get only those models that have real historical value. The remainder, with the sanction of the committee, will be returned to the inventors or their families, awarded to cities and museums that have special interest in them or—sent to the junk pile and destroyed.

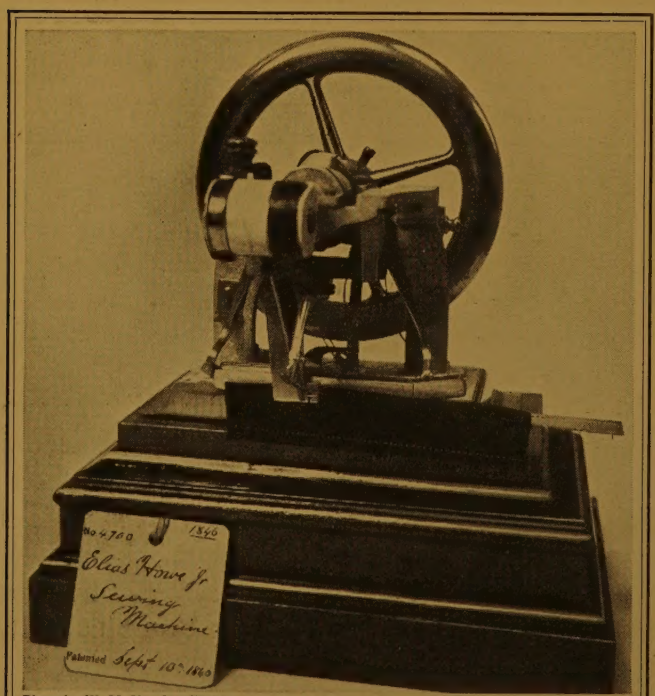


Photo by W. M. Van Der Weyde

A LIFETIME OF WORK AND WORRY WENT INTO THIS MODEL

The Howe sewing machine, which has been such a boon to womankind and saved so many hours of weary toil, was conceived and worked out by Elias Howe through years of suffering and disappointment

Up to 1880 the Patent Office required that models of all inventions be submitted along with all applications for patents. The authorities insisted on seeing the wheels go round. They would take nothing for granted. If an inventor developed a mouse trap he had to prove that it was capable of catching mice. If he had a new-fangled buggy-whip socket he had to show that it really would hold a buggy whip. Models, with red-sealed patent applications attached, arrived by canal boat, stage coach, ox team and, in later days, train. Some were of no earthly account; others were the crude be-

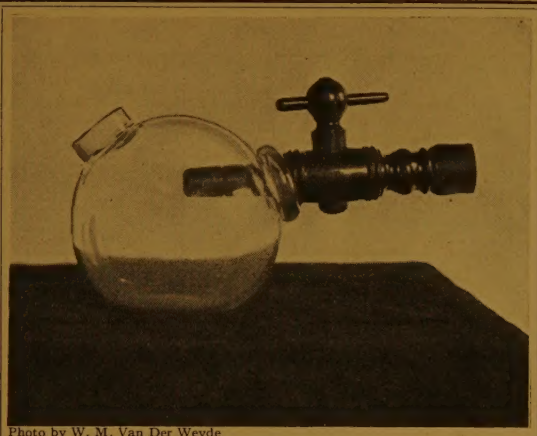


Photo by W. M. Van Der Weyde

ETHER WAS FIRST ADMINISTERED FROM THIS SMALL GLASS BULB

It was with this glass container that the first experiments in anæsthesia were made, when Dr. W. T. G. Morton administered sulphuric ether to a patient in 1846

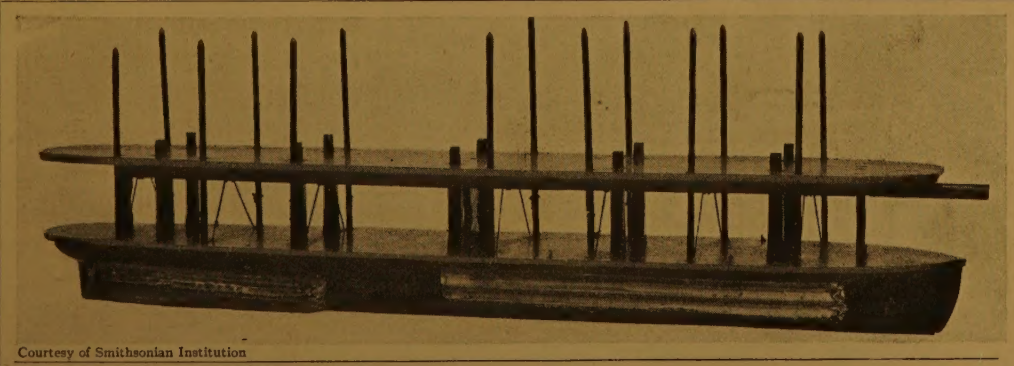
ginnings of inventions which, with their present-day perfection, we now consider essentials of life.

But they all took up space in the offices and corridors of the great stone building that houses the Commissioner of Patents and his associates in Washington. A stranger who happened in was wise to employ a guide to discover the paths around the folding hoopskirt models, magic lanterns and railroad cars. The various contraptions did service as paper weights, ash trays and ammunition against noisy cats at night. "Hereafter," the Commissioner of Patents decreed at length, "we'll have no more models. Drawings will do—and the smaller the better."

The rule worked fairly well, except for flying machines and perpetual-motion devices. Here and there over the country some inventors had been having trouble getting those things to work. In a general way they had the idea of what they wanted to make; and, after all, they were more handy with pen and ink than with tools. The flood of drawings of flying machines and perpetual-motion devices was so large that the Commissioner of Patents was required to revise his decree.

"Drawings will do for everything but those two things—flying and perpetual motion," said he. "After all, the Patent Office is from Missouri."

The Wrights of Dayton and their early associates in the development of aircraft forced an additional reconsideration of the edict; so that now the

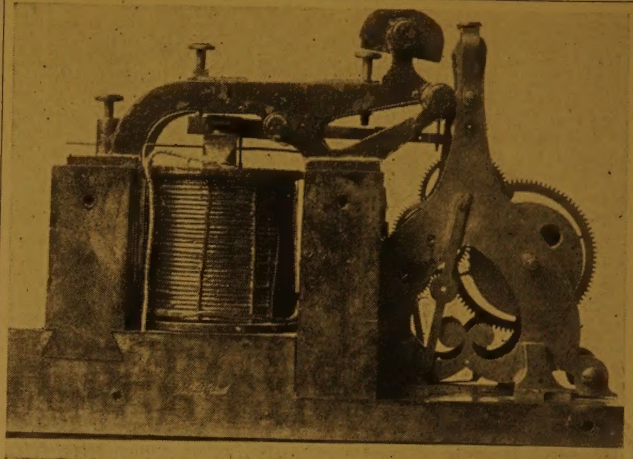


Courtesy of Smithsonian Institution

ABRAHAM LINCOLN INVENTED THIS!

An invention designed to free river boats caught on the sandbars. The patent was obtained in 1849 but nothing came of the invention. The upright sticks running through the deck were intended to make it easier to get the boat loose

only device for which a working model is required with a patent application is one seeking to attain perpetual motion. From time to time models with perpetual motion as their purpose have been submitted to the Patent Office, but the field remains open, as always, for anybody with ambitious ideas along that line.



Courtesy of Smithsonian Institution

THE FIRST TELEGRAPH REGISTER
It is the invention of Samuel F. B. Morse and was patented in 1846

An appreciation of the models that date far back into the early days of the republic must go hand in hand with an understanding of the patent system. The famous "Statute of Monopolies," by which an inventor was to receive a limited enjoyment of his device in return for his public service, was enacted in England in 1623; and naturally enough the justice of that law found a place in the conduct of the American Colonies. The General Court of Massachusetts, as early as 1641, granted a patent to Samuel Winslow for a novel method of making salt, the *first patent granted in America.*

Madison sponsored the patent system during the organization of this government and was instrumental in obtaining constitutional authority for Congress to protect inventors in their developments. With the advocacy of Washington, Congress passed a law in 1790 to establish a board for the examination of applications and the granting of patents. The members were the Secretary of State, the Secretary of War and the Attorney General. Jefferson, the Secretary of State at the time, kept the records and examined all the applications; he, in fact, was the first administrator of the American patent system. In time, of course, the business grew so that a superintendent, Dr. William Thornton, a

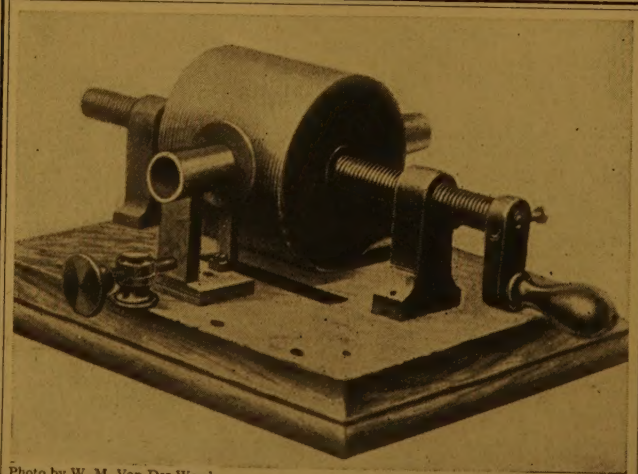
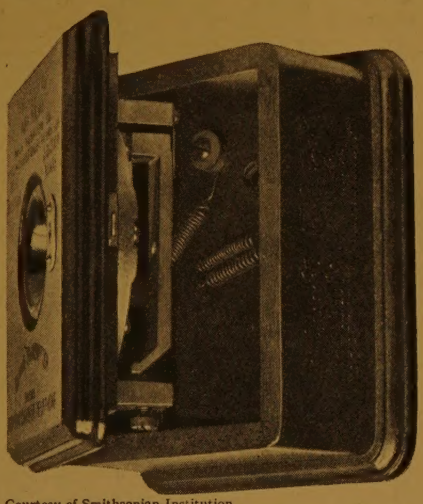


Photo by W. M. Van Der Weyde

THE FIRST TALKING MACHINE
Thomas A. Edison's original model of the phonograph, patented in 1877

picturesque figure of those days, was placed in charge, and he held the position until his death in 1828.

On several occasions, in 1793, in 1836 and again in 1899, there were changes in the law, all for the purpose of stimulating invention; and to-day the American patent system is a model for other nations. Some idea of the regard in which the American law is held may be had from the fact that the Japanese Government, when considering the establishment of a patent system on the lines created by the American Patent Act of March 1, 1899, appointed Mr. Takanashi their special commissioner to Washington, D. C. On being asked why the people of Japan desired to have a patent system, he replied: "It is only since Commodore Perry in 1854 opened the ports of Japan to foreign commerce that the Japanese have been trying to become a great nation, and we have looked about us to see what nations are the greatest, so that we can be like them, and we said: 'There is the United States not much more than one hundred years old, and America not discovered by Columbus until four hundred years ago.' We said, 'What is it that makes the United States such a great nation?' and we investigated and found that it was patents, and we will have patents."

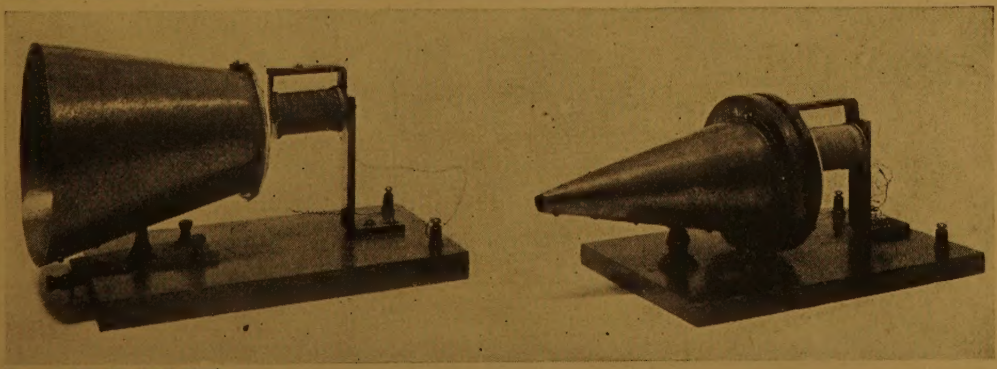


Courtesy of Smithsonian Institution

THE OLD OAKEN PHONE THAT HUNG IN THE HALL

You turned a crank on the side of this wooden box and the bell jingled. This is the original model of the Blake transmitter of the Edison carbon telephone

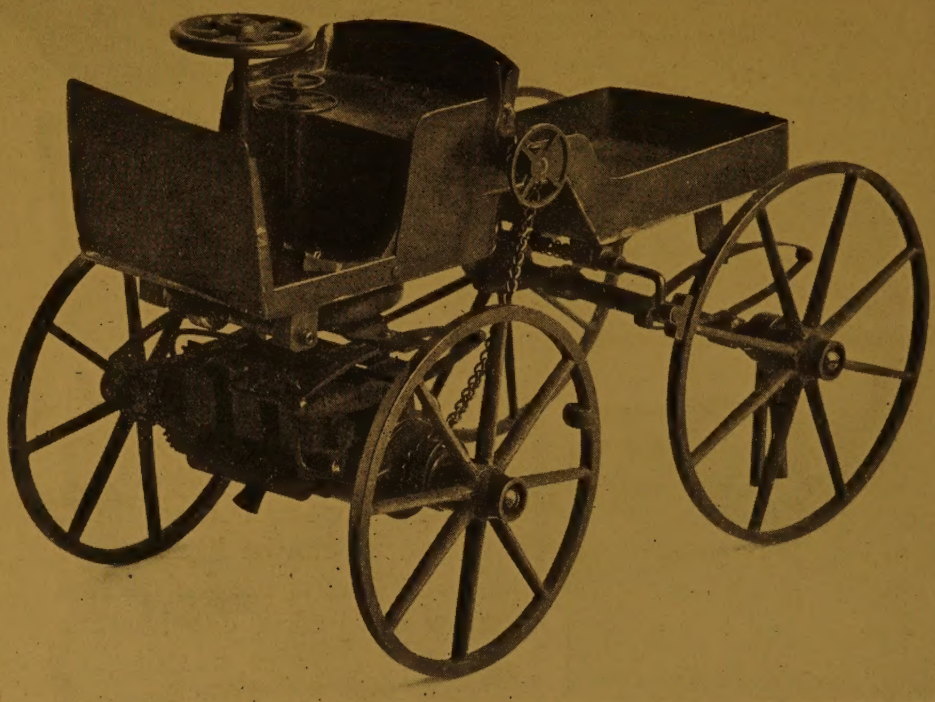
Of the one and a half million patents granted by the United States Government—that mark was reached a little more than a year ago with a patent



Courtesy of Smithsonian Institution

THE FIRST "HULLO!" BY WIRE SOUNDED THROUGH THESE INSTRUMENTS

Alexander Graham Bell's first telephone transmitter and telephone receiver, patented March 7, 1876



Courtesy of Smithsonian Institution

THE ORIGINAL "BENZINE BUGGY"

Many are the familiar names applied to the gasoline auto-going vehicle, but this one deserves the venerable name of "Mother Eve" of motors, for it is the actual, original George B. Selden model, patented in 1895

issued to Simon Lake, of Connecticut, for a new type of submersible vessel designed to navigate under ice—for only about one tenth are there any working models. Still, this is not surprising when it is recalled that by far the greatest number of patents was issued after models no longer were required. It was in 1893, thirteen years after the rule went into force, when Patent No. 500,000 was issued. Patent No. 1,000,000 came in 1911. But, even so, the Patent Office would have had many more working models had it not been for a disastrous fire in 1877, which consumed one of the largest wings of the stone-pillar building and destroyed stacks of valuable records as well as models.

The models now being sent away reveal vividly the different eras in the rise of modern industrialism. The period immediately following 1765, when the steam engine was invented, saw fundamental inventions in textile machines and the application of steam power to machinery and transportation; yet it was only in England at this time that they were put to extensive use. It was after 1836, when rail and steamship transportation developed importantly, that American inventive genius attained its stride, achieving more within fifty years that changed our mode of living and our health and

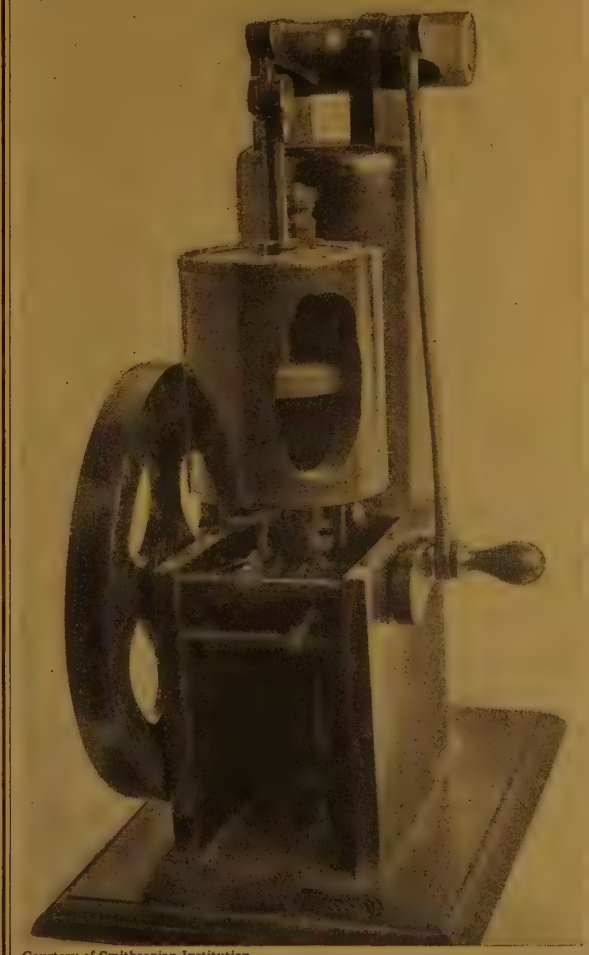
progress than within any one thousand years in the previous history of the world.

The models of the Old Curiosity Shop are of that era rather than of that which followed, running from 1893 to 1911, when inventors gave us the automobile, the airplane and wireless communication and refined the accomplishments of the earlier period, notably extending the use of electricity for machinery and transportation. Nor are there any models on hand picturing the present era of invention, which, for the most part, has centered upon the perfection of labor-saving devices and the development of instruments having to do with automatic telephony and radio communication.

Of the models already transferred to the Smithsonian Institution none is more interesting or recalls a more pathetic story of defeated hope than that of the sewing machine invented by Elias Howe in 1846. What this ingenious device meant to the future of the world Howe never had the opportunity to suspect. He died in Brooklyn, N. Y., in 1867, ill and almost broken-hearted, without enjoying the fruits of his persistence and skill, although twenty-one years had passed since he had obtained his patent.

His patent, No. 4,750, obtained in 1846, was followed closely by others, including those of Allen B. Wilson in 1850 and 1852, and by that of James E. A. Gibbs in 1857; so it was that a long patent war developed so intensely and so bitterly that Howe never was able to capitalize his product. His experience was that of hundreds of others in the history of invention.

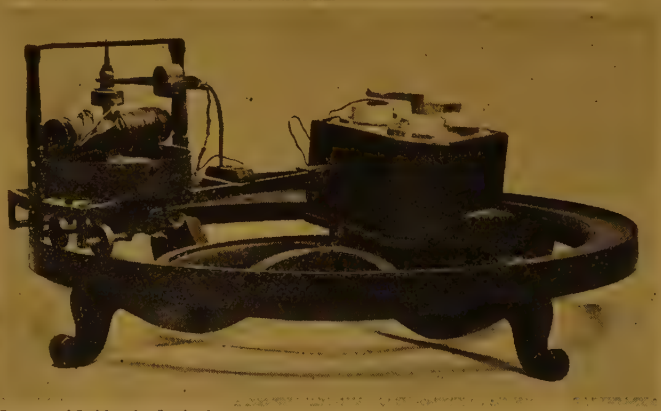
The experience of John Fitch in the invention of the



Courtesy of Smithsonian Institution

THIS IS THE GASOLINE ENGINE THAT STARTED IT ALL

The automobile and the airplane waited for the invention of the gas engine. This original model, patented in 1874 by G. B. Brayton, figured importantly in the famous Selden patent suit. Selden, in obtaining a patent for the first gas-driven automobile, had used the Brayton engine and collected royalties from automobile manufacturers until Henry Ford established the point that the manufacturers were employing the Otto, not the Brayton, type



Courtesy of Smithsonian Institution

THE BEGINNING OF THE END OF HORSE CARS

If it hadn't been for this we'd probably still be jingling along on street cars drawn by horses. The Davenport electric tram, pictured here, was patented in 1837. It was the first important development for electric railways and the beginning of electric street railway transportation

steamboat was equally as sad. Fitch, although his contribution was of the utmost importance, met with little but ridicule that drove him into virtual exile in Kentucky where, at last, in desperation, he committed suicide.

There is no model of Fitch's boat. So far as officials are aware there never was any except that which he built to ply in the Delaware River and demonstrated to Congress at Philadelphia in 1787. But still the Smithsonian, after diligent research, has built a replica that serves the purpose, just as it has constructed a replica of Robert Fulton's steamboat, the *Clermont*, on which he rece ved exclusive rights of transportation on the Hudson River between New York City and Albany.

There was, however, a little sunshine in Fitch's story. Long after he died it came to light that the king of France had recognized his invention in a communiqué which, strangely enough, was picked up undamaged among the charred embers after the fire in the National Library in Paris.

The original models of both the Brayton and Otto gasoline engines, which made possible the automobile and the airplane, are in the glass cases of the Smithsonian. G. B. Brayton obtained his patent in 1872 and N. A. Otto in 1877. Their technical differences in principle had an important bearing on the now-famous Selden controversy.

George B. Selden was a lawyer and the patent he obtained on November 5, 1895, was the result not so much of his mechanical ingenuity as his foresightedness that gas-propelled vehicles eventually would be developed as a factor in everyday life. His idea soon proved correct, so he was able, when the country started producing automobiles, to demand and collect royalties from the manufacturers; Henry Ford it was who fought it out with Selden, developing the vital but hitherto never considered point that Selden's patent had been not for the application of the Otto gas engine, which was being used in the automobile, but *for the Brayton type of engine.*

The original of Thomas Davenport's electric railway motor is on display, a patent having been granted February 25, 1837; but it was many years later that the street car became a fact, in Germany, and the Vermont blacksmith who made it possible never knew the extent to which his work was employed.

Somewhere among the 155,000 models in the old livery stable is the original of Thomas A. Edison's incandescent lamp. Edison himself told the story of how he had underestimated the value of his product.

After obtaining the patent he began negotiations with a company to manufacture the electric lamp. On the night preceding the conference that was to settle the terms he talked with his wife about the price he should ask, and they agreed it should be $2,000.

Next day, when asked how much he wanted, Edison cleared his throat, getting ready to mention $2,000. But the manufacturer misunderstood.

"Would $100,000 advance royalty do as a start?" he asked.

"Oh, sure," Edison stuttered as his throat filled up again. "Sure."

Edison has more models on display than any other inventor; naturally enough, since he has more patents to his credit than anybody else, his record running unbroken with inventions every year since 1869.

Alexander Graham Bell's original models of the telephone are set on unpainted wooden blocks and seem very crude. Duplicates of these models, at the Centennial in Philadelphia the year Bell obtained his patent, brought this development to public attention in an unusual way:

Bell, in charge of the exhibit, had been unable to arouse interest in his invention. People hurrying along to see the wonders of the exposition passed him by with a shrug, assuming that his was only another wild idea.

Courtesy of Smithsonian Institution

MEN HAVE MADE AND LOST MILLIONS TO THE TUNE OF THIS MACHINE

More stories of fortune and defeat have been told on this little instrument than in all the novels ever written. The stock ticker of to-day has been improved greatly since the original printing telegraph patented in 1852 by Royal E. House, but its function is just the same

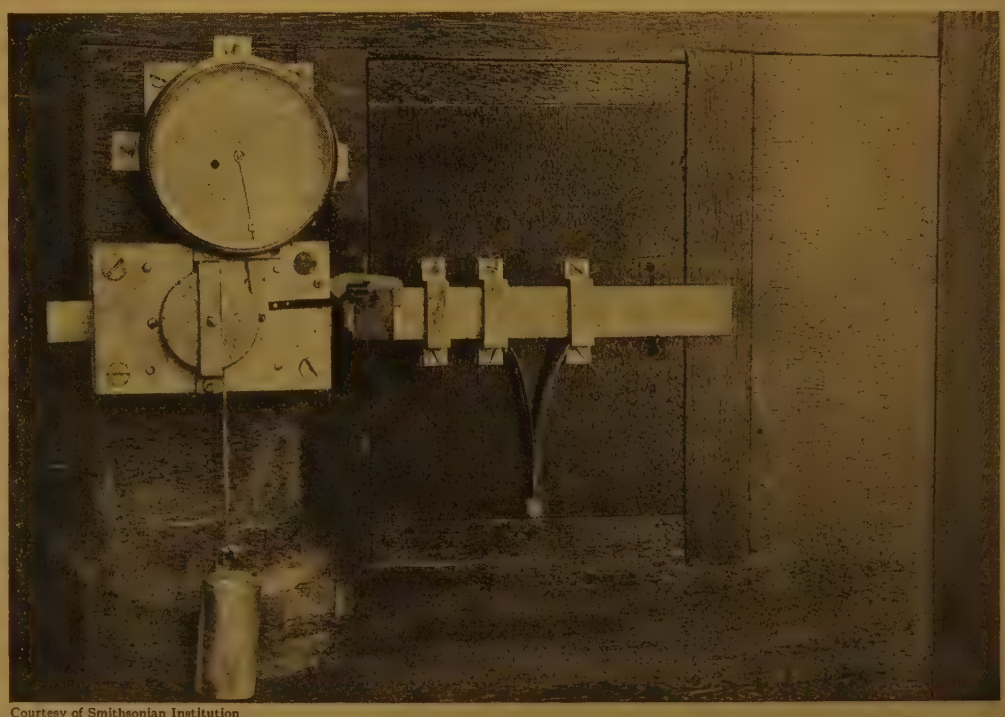
But late in the year the emperor of Brazil visited the Centennial. He had around him his staff and a special committee that rushed him hither and yon and seemed annoyed when he wanted to see what Bell had to show.

Somebody tugged gently at the emperor's coat while he put his ear to the receiver. Bell's voice came over the wire, clearly and distinctly.

"My God, it speaks!" the foreign dignitary exclaimed in amazement.

The attention directed to the Bell telephone by this incident led to the invention being taken up seriously. The strides in its development within the last fifty years becomes more striking if a visitor in the Smithsonian turns from the little unpainted models to the adjoining case in which there is a modern telephone with an automatic switchboard capable, by the simple turning of a dial, of finding its own connection.

From the beginning of the American patent system there have been countless inventions involving the art of printing. The fourth patent issued by the United States Government was for a new method of punches and matrices for making type and went to Francis Bailey of Philadelphia, in 1791, with the signature of George Washington. That is the only authentic facsimile copy in the possession of the Patent Office of any patent granted in the early days of the American republic. Whether the model exists nobody knows. Perhaps it yet may be uncovered in the Old Curiosity Shop.



Courtesy of Smithsonian Institution

THIS CLOCK MARKS ONE LATE OR EARLY—AND ACCEPTS NO EXCUSES

J. G. Savage invented his time clock in 1847 and its development has been a great factor in modern commercial efficiency

WOMAN'S CONTRIBUTION IN THE FIELD OF INVENTION

MARY ANDERSON

Since 1919 director of the Women's Bureau of the Department of Labor. As a young girl Miss Anderson came to the United States from Sweden. Factory experience in the Mid-West preceded an extensive tour of the country as a representative of women's industries. In her official position, and as an active member of many labor organizations, Miss Anderson is in close touch with the conditions affecting women's work, and is an ardent champion of her sex in industry

For nineteen years after Congress passed the first patent law 10,000 patents were issued by the government, but none to women. In 1809, however, a woman obtained a patent for a method of weaving straw with silk or thread. Since then women have been increasingly active in the field of invention.

Up to the time of the Civil War women obtained about a dozen patents a year, but during and immediately following the war the number frequently increased to more than a hundred. The period of the World War had much the same effect. In 1918 the number went to 666, and to-day it is only a little less. At present an average of 500 patents is granted to women each year.

Patents obtained by women have a wide range in character. New automatic pistols and better horse collars occupy their minds as well as improved hairpins and household utensils. In striving for improvement they have not overlooked any important sphere of industry, commerce or the sciences.

The achievements of women in invention recently was the subject of a survey by the Women's Bureau of the Department of Labor, of which Mary Anderson is the director. Ten representative years, between 1905 and 1921, were selected. A search of official records resulted in an analysis of the 5,016 patents granted to women in that period.

Of the total number of patents obtained by women, half pertained to domestic appliances and articles for personal wear and use. Inventions for use in industry, agriculture, commerce and the home were 7.5 per cent; safety devices for trains, street cars, automobiles and aircraft, over 6 per cent. Agriculture, mining, manufacture, dressmaking, ordnance, safety and sanitation and medical equipment were on the list.

In drawing its conclusions of the survey the Women's Bureau found that "the rate of increase in the number of inventions patented by women and the range and quality of their inventive achievements furnish an argument for expanding women's opportunities for research and experiment."

THE FIRST TYPIST—THE DAUGHTER OF CHRISTOPHER L. SHOLES

Writing on one of his experimental machines. From a picture in the possession of the Herkimer County Historical Society, New York

THE STORY OF THE TYPEWRITER

Those Who Thought of It First and Were the Pioneers in Making It

BY CAXTON FRAZIER

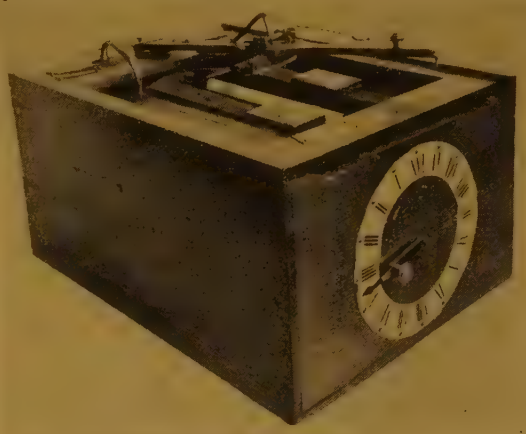
CHRISTOPHER L. SHOLES, INVENTOR OF THE FIRST PRACTICAL TYPEWRITER

"I feel," said Mr. Sholes in the early days of typewriting, "that I have done something for the women, who have always had to work so hard. This will enable them more easily to earn a living"

To the United States belongs the credit for the invention and perfection of the writing machine; to England the credit for the undeveloped idea. It was January 7, 1714, when her Majesty Queen Anne granted a patent for a typewriter to Henry Mill, an English engineer. In the quaint wording of the records in the old British Patent Office, Mill's was to be "an artificial machine or method for the impressing or transcribing of letters singly or progressively one after another, as in writing, whereby all writings whatsoever may be engrossed in paper or parchment so neat and exact as not to be distinguished from print; that the said machine or method may be of great use in settlements and *publick records*, the impression being deeper and more lasting than any other writing, and not to be erased or counterfeited without manifest discovery." At this late date nobody is able to say whether Henry Mill built a model of his machine; if he did, it certainly did not work. Nothing tangible remains but his patent papers.

Many great events had transpired and the new American republic was well on its feet before the world saw another step toward the development of the typewriter. William Austin Burt of Detroit, who won fame as the inventor of the solar compass, obtained a United States Government patent for such a machine in 1829. His device consisted of an assembly of type bars arranged in a circle, each type striking down upon a common center.

Burt built a model and wrote on it; his first letter, still in a good state of preservation but revealing his difficulties in keeping the type in alignment, hangs framed on the wall of the Smithsonian Institution in Washington. His original model was destroyed in the Patent Office fire in 1877, but Patent Office experts, working from a description among papers in the possession of Burt's family, produced a replica, which was displayed at the World's Fair in Chicago in 1893.



Courtesy of the Smithsonian Institution, Washington, D. C.

EARLIEST TYPEWRITER INVENTION

William Austin Burt of Detroit had a big idea when he patented this typewriter in 1829, but it stopped at that; this model is a replica of the original which was destroyed in the Patent Office fire in 1877. The first letter written on it hangs in the Smithsonian Institution in Washington

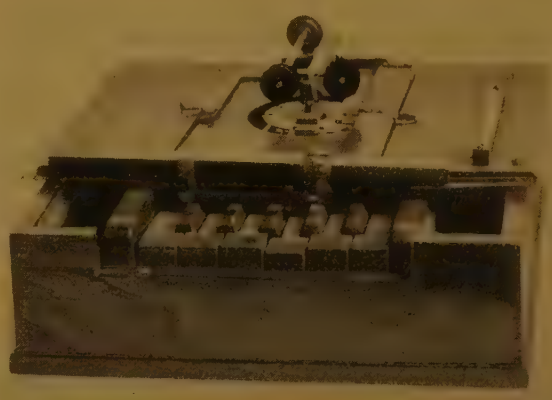
The word "typewriter" had not yet been coined. For want of something better this was known as "Burt's Family Letter Press." The invention attracted wide interest but little else. The machine was not put into manufacture commercially.

Xavier Projean of Marseilles obtained a French patent in 1833 for a machine which, like Burt's, was little more than the germ of an idea. The device he invented, as well as half a dozen or more that followed within the next few years, had for its purpose the preparation of manuscripts for the blind. During the "fifties" there was activity in typewriter invention. But the machines were of scant importance; they were cumbersome, slow and toylike.

The birth of the first practical typewriter in the late "sixties" gave Milwaukee still another cause to be famous. In a little machine shop in the outskirts of the Wisconsin city Carlos Glidden, Samuel W. Soule and Christopher L. Sholes, none of them mechanics, started work on a writing device.

As the trio struggled along they came upon a copy of the "Scientific American," which quoted an article from a London technical journal describing a machine called the "Pterotype," invented by John Pratt, another attempt at a typewriter. None of the three knew there had been any prior effort to do the thing, except by Pratt; they plunged into the subject with fresh eagerness, unhampered by a knowledge of anything that had been tried by other inventors.

Of course the employees of the machine shop became interested in the proposed typewriter, among them Matthias Schwalbach, who con-



Courtesy of the Smithsonian Institution, Washington, D. C.

SHOLES TYPEWRITER

It looks a little like a parlor organ, but it is the original model of the Sholes, Glidden and Soule typewriter patented in 1868, the *first machine to be commercially successful*

Photo by W. M. Van Der Weyde

THE ALLEN MODEL

R. T. P. Allen's original typewriter model, 1876. The keys are the Allen children's building blocks

tributed greatly to the development. The work continued for some months, until the fall of 1867, when the first machine was finished, although a patent was not obtained until the following June; the odd-appearing device wrote accurately and rapidly, but had, naturally, many defects.

The three inventors typed letters on it to their friends, among them James Densmore, of Meadville, whose enthusiasm prompted him to buy an interest in it by paying all the expenses already incurred. Densmore, a man of practical affairs, supplied the business energy the inventors lacked; in time he succeeded Soule, who dropped out, and the trio continued as Sholes, Glidden and Densmore.

The early defects of the typewriter, the name for which was supplied by Sholes, were eliminated by the advice of friends and other enthusiasts and by the tedious construction of new models, of which there were twenty-five or thirty up to 1873. By that time the machine had reached an early perfection that warranted its commercial manufacture by the Remington gun-making concern, which contributed greatly to its development.

The introduction of the typewriter into everyday life came only after numerous business ups and downs; machines at $125 apiece had to compete with steel pens at a penny apiece and years passed before the world entered the typewriter era. To-day, the sound of the scratching pen has almost ceased, and the click of the typewriter is heard all over the land.

PAPER MAKING, FROM PAPYRUS TO THE PRINTED PAGE

Our Civilization is Built on Paper—on Books, Magazines and Printed Records—a Story 2,000 Years Old

BY ROYAL S. KELLOGG

Papyrus, the writing material of the ancient Egyptians—made from the perennial, rush-like plant of the sedge family (from it the word "paper" is derived), served its purpose for thousands of years, but it was not until Ts'ai Lun devised a process of maceration of wood in China about 130 A. D. that the world had real paper. Even so, it has been only within recent years that science has made possible the production of paper at low cost and in the great quantities required to meet present-day demands.

The story of its invention and the 2,000-year development of its manufacture has at times been told, but usually in a technical way. It has remained for Royal S. Kellogg, speaking with authority, to bring out the romance of paper making by a novel way of presenting the subject.

Mr. Kellogg, the author of several books on paper and paper making and a leader in the forestation movement, conceived the interesting idea of presenting the story of Ts'ai Lun in dramatic form. So, on the occasion of an assembly of scientists and manufacturers engaged in paper industries, Mr. Kellogg, arrayed in Chinese robes and impersonating the wise old Chinese minister of agriculture who invented paper, told the story of Ts'ai Lun, as follows:

I am Ts'ai Lun, minister of agriculture under the Celestial Emperor Ho-Ti and made by him a marquis in the year which the Christians call 114 A.D., but which, according to the true calendar of the Flowery Kingdom, was 592 years after the death of Confucius.

AN EGYPTIAN PAPER MAKER
Making writing material from the stems of the papyrus, a plant found on the banks of the river Nile

During the many years of my life, always with the help of the wise and good Ho-Ti, I brought various plants from the far places and caused them to take root, flower and fruit in the Imperial Gardens. Then the seed therefrom was carried to gardens elsewhere, sown according to my direction, and the yield thereof increased manifold.

PAPER MAKING IN CHINA
Breaking up fiber. In the background a vat for cooking fiber

Moreover, I taught the people to plant rice this year, beans next year and another crop the year after, because I found that the great Mother Earth does not take kindly to the same seed each year.

Thus it was that the people had more and better rice to eat and tea to drink, larger shoots of the bamboo with which to build shelter, more cotton for weaving and still finer silk when they were taught to choose and care for the worms that lived in the thickly leaved branches of the mulberry trees.

And there was peace and plenty in the realm of the potent Ho-Ti.

Because of these things did the emperor raise me, a man of lowly origin, to the rank and station of marquis.

✣ ✣ ✣ ✣ ✣

Yet was there always need for some light material, not so costly as silk, nor so cumbersome as bamboo, upon which to record the wisdom of our sages, the proclamations of our emperors and the deeds of our great men.

One day did the mighty Ho-Ti say unto me:

"Ts'ai Lun, how wilt thou leave behind thee directions so that those who come after thee may learn to do these many things that thou hast discovered? What availeth all thy labors if there be no way in which thy learning may be passed on to those who follow in cycle after cycle?"

Thus spoke the great emperor in whom all wisdom was manifest and whom none might dispute.

What might I do? None of the fathers had used aught but silk or bamboo whereon to paint the beautiful characters that recorded the learning of

ANOTHER STAGE OF CHINESE PAPER MAKING
The sheets are being taken from a mold and laid on a stone to dry in the sun

our sages and the laws of the emperors. How could there be anything better than they had used?

One night of the moon wherein the harvest is gathered, when I could not sleep because of the charge laid upon me, there appeared before me the spirit of Confucius, who said:

"Ts'ai Lun, go thou to the tree which feedeth the silkworm. Remove the bark in strips, leaving somewhat of bark so that the tree will not die.

"Then do thou separate the fibers and place them in a vessel in which there is lye leached from the ashes of wood, saving the outer bark that thou mayst make a fire under the vessel.

"When the fibers have been in the vessel one cycle of the moon, thou shalt put them upon a rock and beat them with a stout cudgel, after which thou shalt put them into a vat with much clean water and stir them until they become exceedingly fine.

"Then thou shalt make a frame of bamboo one cubit square, with a fine screen across the top made of bamboo splints tied evenly with silk. And upon this screen shalt thou place another frame like unto the first, except that it be open at one side.

"Then shalt thou grasp them firmly in both hands, dip evenly into the vat of fibers, lift up and shake gently to and fro that the water may run through the screen, and thou wilt find upon it a wet sheet of tangled fibers.

"Then shalt thou remove the frame and place the sheet upon a clean cloth, placing another cloth over it. Then shalt thou dip the sheets into warm water wherein the hoofs and horns of cattle have been boiled, and dry them again. And at last thou shalt rub them to great smoothness with a polished stone.

"Then shalt thou take the sheets to the Emperor Ho-Ti and tell him thou hast made this wondrous new material upon which the deeds of mankind may be inscribed and put into the hands of all the people."

Courtesy General Electric Co.

MODERN METHODS OF MAKING HANDMADE PAPER
Pressing and drying handmade paper in more recent times

Thus spake the spirit of Confucius, standing in the light of the Moon of the Harvest before my door.

And it was even so. And when the Emperor Ho-Ti held in his hand the light, strong sheets made from the inner bark of the silkworm tree he said:

"Ts'ai Lun, because of

A FOREST OF PAPER-MAKING MATERIAL

Young growth of spruce and balsam fir in New Brunswick. This will be paper-making material in a few years

the greatness of thy accomplishment thou shalt not die as other men do, but instead thou shalt, each fourscore years, renew thy youth and go from land to land, teaching the people to make and use this new material.

"And in each country thou shalt be as one of the men therein born and thou shalt work with the substances thou findest at hand, so that none will suspect thee and all will take great pride unto themselves for their inventions, albeit thou wilt always know the truth of their claims and inwardly rejoice at the learning that came from the land of Confucius.

"For the kingdom of learning is greater than the kingdom of arms, even as the conquest of knowledge is more enduring than the conquest of the sword."

Thus spake the Emperor Ho-Ti and all his words became living truth.

For 1,800 years my spirit has gone from land to land, from continent to continent, from China to Turkestan and to Arabia; thence to Spain, Italy and France; thereafter to Germany, England and Sweden—and finally to the great new country on the western side of the Atlantic.

And I have everywhere worked with the substances men were familiar with and the tools they knew how to handle. So it was that a hundred years after I made paper from the mulberry tree I taught my own people of the Flowery Kingdom how to make even a stronger and better paper from rags of cotton and flax, and also a cheap paper from the straw of the rice plant.

And it was from rags that the craftsmen of Arabia and of Europe and of America learned to make paper, and for 1,700 years but little paper was made of aught else—*and no better paper has ever been made than was made in those days.*

Yet a man with much labor and sweat could make only a little pile of sheets a day.

FINISHED ROLLS OF NEWSPRINT PAPER

Ready for shipment to the vast printing establishments that spin the paper web into printed newspapers and magazines

OLD AND NEW METHODS OF LOGGING

A FOREST OF LOGS
Lying in a mill basin, waiting to be made into paper

Learning was carried throughout every land, but books were dear and hard to get, and mostly kept in the temples by the priests who wrote the words therein by hand or mayhap printed a page at a time from shapes cut into a block of wood.

A better way must be had if there were to be more books, so one day when I found a man in Germany named Gutenberg, who had more sense than most, I told him that many centuries before, in far-away China, printing had been done with single types each representing a character so that, by making many of these types, they could be put together quickly in the form of words for the page of a book and then set again for another page. This man had much skill with his hands as well as with his head. He printed a sacred book and thereafter there was so much printing that more paper must be had.

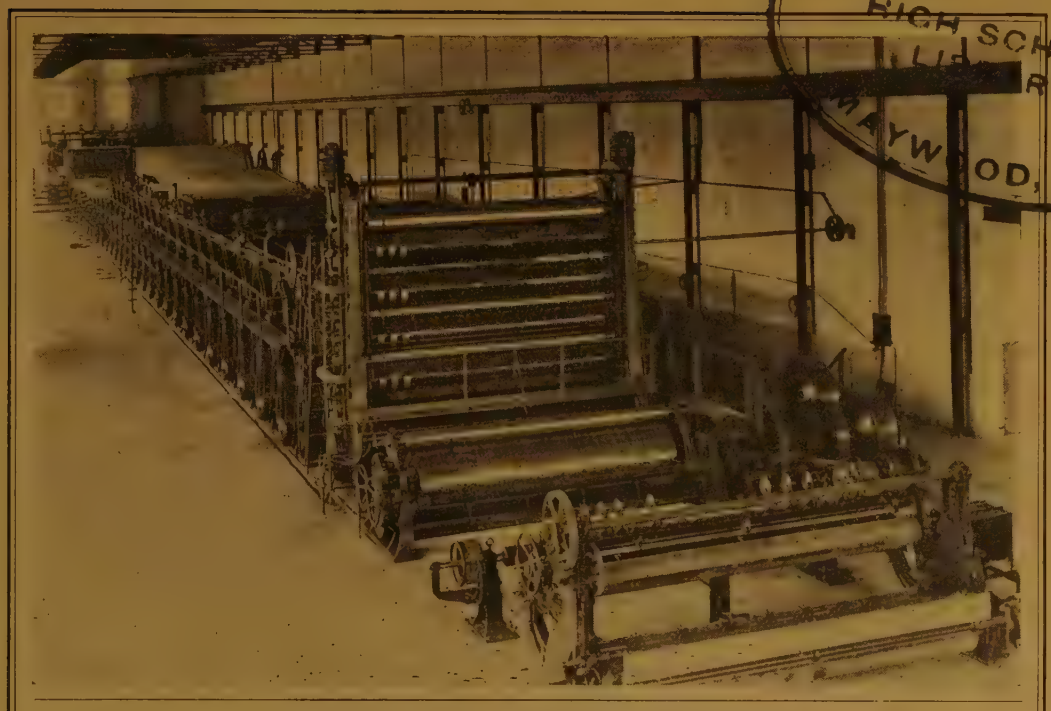
Next I caused a Dutchman to make a great vat in which was a heavy wheel with sharp edges and turned by water power so that fibers could be beaten up quickly and more men kept busy with the frames and screens.

Then did I cause a Frenchman, Robert by name, to make a great wire screen moving over pulleys so that the water would fall through the screen and leave the fibers on it, after which the wet sheet was run over hot iron cylinders and dried quickly.

This was the beginning of paper making as people know it to-day and was during the period of my twenty-second rejuvenation.

THE MIDDLE STAGE OF PAPER MAKING

Here you see pulp in thick, wet sheets from the first screens ready to be put through the next screening



A HUGE MODERN PAPER-MAKING MACHINE
This machine produces paper at the rate of 1,000 feet per minute

And men too made new machines for the types so that there was much printing of books and the things called "newspapers," unknown to my people.

But not for long was there enough paper even when it was made by machines, because there could not be found enough rags of cotton and linen. So men did try many strange substances—even grass and leaves and straw and seaweed and stalks of many plants—but with little success for most.

And when I was unable to solve the problem did the spirit of the great Confucius come to me once more during the Moon of the Harvest and say:

"Ts'ai Lun, as thou first went to the tree, go thou again, but this time take not the bark, for it is not enough.

"Take thou the solid wood itself.

"Hold blocks of it firmly against a turning stone with water thereon so that it is ground finely and yet most of the fibers left unbroken.

"This when washed and screened as thou knowest how to do will give thee much paper-making material—not so good as rags, but cheap and plentiful so that men may have newspapers and papers of divers other kinds."

Thus again spake the great Confucius. And it was even so. There arose paper mills in the forests and along the streams where there was much falling water to turn the stones, and ten men were making paper where there was one before. Great rolls of paper came from them ready for the other machines that held the little types.

And then men put the forms of the types on great cylinders and turned them even faster so that thousands of books and newspapers were printed where there was one before.

And there were schools; and all the children learned to read and write.

And then other men made a wondrous machine that set more of the little types than seven could do, so that there were more books and newspapers and magazines than ever before; and more paper was used in other ways, so there was not enough paper until more mills with bigger machines were built.

And merchants took much space in the newspapers and magazines to tell of their wares, and trade was greatly increased thereby.

And all manner of business was done by means of paper, and paper was used in the place of other substances for many purposes.

And then the printing machines were made bigger and swifter, so that twoscore thousand newspapers might be printed in an hour; and the paper machines were made still bigger and swifter, so that one machine might make paper enough in a day to cover four hundred acres of land.

And people began to say again that there was not enough wood to make paper and something else must be found or there would be no more paper.

And then the foresters arose and said that there might be wood enough if the people were careful with fire and did not let the forests burn up and that the thing to do was to grow trees and cut them when they were large enough and then to grow more trees, so that there would always be plenty of paper.

All-wise Ho-Ti spake truly when he said that a kingdom of knowledge is greater than a kingdom of arms.

And I shall carry out his charge as long as the world endures, for I am the Spirit of Paper Making.

A HUGE PULP AND PAPER MILL IN NEW YORK STATE

HOW CATSKILL WATER CAME TO GOTHAM

THE STORY OF THE GREATEST AQUEDUCT IN THE WORLD

BY JEROME W. HOWE

KENSICO DAM IN COURSE OF CONSTRUCTION

THE BIG FACTS AND FIGURES OF THE AQUEDUCT

It is 160 miles in length and was 20 years in building; it employed 19,000 men and cost $185,000,000.

The aqueduct passes under the Hudson River, under the East River and under the bay to Staten Island. The pipes are, in places, 17 feet in diameter and can deliver a total of 5,000,000 gallons a day.

The volume of water held in storage ready for demand when all reservoirs are full averages 177,000,000,000 gallons.

To supply this water, 571 square miles of land was drawn upon, and over 10,000 acres of cultivated land, including nine villages and many farms, were wiped out and submerged.

The Shandaken Tunnel, which carries the waters of the Schoharie Creek to the Esopus River under a mountain range, is the longest tunnel in the world—18 miles in length.

The water tunnel in New York City is nearly as far under the pavement as the tower of the Woolworth Building is above.

Courtesy Board of Water Supply, N. Y. C.

ESOPUS GORGE, LOOKING DOWNSTREAM

In this peaceful and picturesque little river we see, close to its original springs, the Catskill water that finally finds its way to thirsty throats in New York, Brooklyn and Staten Island. Catskill water has its sources in the Esopus and Schoharie watersheds

HOW CATSKILL WATER CAME TO GOTHAM

THE Catskills of Rip Van Winkle still print their bold outlines on the sky; and much of their ancient beauty and romance remains. Much, however, is changed, and in no respect is the change more noteworthy than in the alteration that the labors of the New York water supply forces have produced in the landscape during the brief space of the twenty years just past.

The thirst of the ever-growing metropolis of New York has attained inordinate proportions. The wells and local streams that comprised Father Knickerbocker's water supply became inadequate at an early period, and gave place to simple public water works. Then epidemics of yellow fever and cholera and a disastrous fire hastened the construction of works for bringing to the city a purer and more plentiful supply of water from the Croton River. Water pipes of wood gave place to new pipes of cast iron, and for a long time the city had good water and in abundance. But at length the increasing concentration of humanity within its limits demanded additional supply.

Toward the end of the last century mild agitation on the part of individuals sprouted into a demand from organized bodies for investigation into the need for an additional water supply. The feeling grew that, as Mr. Freeman, the engineer engaged to conduct the examination, expressed it, there should be "a progressive line of development and extension of New York's water supply for a long future."

Mr. Freeman made the first comprehensive study of possible new sources of supply, and he overlooked nothing. He examined all the regions near and far that offered natural conditions that seemed favorable to the project.

Even the practicability of bringing water from the far-away Adirondacks was duly considered. Then Mr. Freeman reported on the advisability of developing the Esopus Creek watershed. The Esopus ("Small River" in the Indian tongue) is a clear, limpid stream that comes down through the Rip Van Winkle country to Kingston. After turning north at Kingston the Esopus empties into the Hudson at Saugerties.

The engineer said: "By building the dams higher (than proposed by a company which had already planned its development), if deep borings show this to be safe; by flowing out the thriving village of Shokan; and by flowing out the present railroad location, the

Courtesy Board of Water Supply, New York

THE LONGEST TUNNEL IN THE WORLD

A view of the inside of the Shandaken Tunnel, which carries the water a distance of eighteen miles under a mountain range, from the Schoharie Reservoir to the Esopus

Courtesy Board of Water Supply, N. Y. C.

VIEW OF SHOKAN AND THE VALLEY

This is one of nine villages demolished to make way for the vast reservoir. The picture opposite shows the same scene as it is to-day

Esopus might, with considerable disturbance of population and the flooding of a large proportion of all the good land in the valley, be given storage sufficient at most for a safe yield of one hundred and fifty million gallons per day, or could, by long and extensive tunnels from the headwaters of the Esopus to the head of Schoharie Creek, be made to furnish somewhere between two hundred and two hundred and fifty million gallons per day." In substance this latter project was subsequently adopted. And, in the sequel, it was discovered that more water was available from these two combined watersheds than the aqueduct had been planned and constructed to carry. Between them they can be counted upon with utmost safety to supply the five hundred million gallons per day that the completed project contemplates.

TWENTY YEARS AGO AND NOW

Consequent upon the preliminary investigation and after more careful studies and surveys, the metropolis was, in 1905, committed to an engineering project of scope and magnitude second only to the construction of the Panama Canal, which was to proceed without interruption from that day to the present, which sees the final stages of the work about to be happily concluded. One hundred and fifty miles from Manhattan the northernmost limit of the Catskill water supply development is rapidly nearing completion in the shape of the Gilboa Dam, which is to turn back the racing waters of the tumultuous upper Schoharie and send them back through a great hole in the mountains to the Ashokan Reservoir, a beautiful and far-extended sheet of water which, though created by the labor of man, rivals the far-famed lakes of Scotland.

UNDER THE HUDSON RIVER

Father Knickerbocker's well sweep reached this lovely valley and drew from it the first draft of sparkling mountain water just before the year 1915 came to an end, a decade after the great plan for the Catskill development was approved. Now another decade, and the original bucket is about to be doubled in size!

Out of this grand project, of which the full history embraces more than a quarter of a century, a few features stand forth in relief, and challenge the attention and admiration of even the individual utterly unversed and mostly uninterested in engineering works.

There is no feature of the whole aqueduct more fascinating than the Hudson Pressure Tunnel—a tunnel that man cannot visit nor view, a tunnel without portals, without light,

Courtesy Board of Water Supply, N. Y. C.

A VALLEY TURNED INTO A LAKE

Villages and farms were sacrificed and cultivated bottom lands submerged to make this vast reservoir

without air; a deep, subterranean rock-bound river flowing always full, flowing *crosswise and far underneath* the Hudson. Above, a broad sheet of water reflecting the heavens: the handiwork of Nature; below, the unseen river, strictly confined within its circular tegument of concrete: the river made by man!

Among the subterranean marvels of the world—the catacombs and tombs, the mines and caverns, the tunnels and tubes and deep piercing wells—this Hudson crossing of the aqueduct deserves a high place.

Within a short distance of the crossing the ceremonies were held to commemorate the commencement of construction of the aqueduct. This was on June 20, 1907. With a special spade of mahogany, Mayor George B. McClellan turned the first sod. Thus was begun a vast structure, to repeat the words of the orator of the occasion, "a structure so vast that, by comparison, it will challenge the mightiest public undertakings of both ancient and modern times."

Five years later another mayor, William J. Gaynor, accompanied by Engineer John Freeman, of whose vision and brain this great work is so largely a fruit, Board of Water Commissioners Strauss, Galvin and Chadwick and Chief Engineer J. Waldo Smith, stood within the tunnel under the Hudson River and switched on the electric current which exploded the last remaining section of rock between the two long shafts that had reached out from under either bank of the majestic stream to meet and mate.

To-day a river of Catskill water pursues its steady, uninterrupted and rapid flow under—far underneath—that other mighty river that Hendrik Hudson explored in his venturesome little bark.

This crossing of the two rivers, one under the other, is appropriately monumented by Storm King Mountain on the west and Breakneck Mountain on the east, bold, hardy, weather-beaten sentinels standing guard over the tunnel shafts.

THE AQUEDUCT

When you stand by the outlet works of Ashokan and admire the play of water in the aërator, which, duplicated at the Kensico Reservoir nearer to New York, affords to Catskill tourists a scene of aquatic playfulness comparable to that which Parisian bourgeoisie travel out to Versailles to see, you should take note of the fact that this happy lark of the waters is their last look at the sun until they pour into Kensico, eighty miles distant. This is the upper end of the famous Catskill Aqueduct.

Here and there, between the city and the Ashokan, one may see where the surface has recently been laid open, and at these incisions will note with interest how a great circular steel shell is being laid on cradles of concrete and riveted up, lined on the inside with cement grout, covered on the outside with concrete and then buried in a long mound that runs true and straight across a valley. And the laborers will point to one side and tell you that this is only a twin to "the other one over there," likewise buried.

In a little while all these pipes will be in, and then, along the whole hundred miles and more of aqueduct, you will see only, at intervals, the low embankment stretched across the land, and, here and there, a pretty, sturdy, tile-roofed structure of brick or artificial stone that houses the valves and gates to control the flow or shut it off as may be necessary.

For considerably more than half the distance to Kensico and part of the way below, the aqueduct has the form of a giant horseshoe seventeen feet both in height and in width and made of concrete. This was built in a trench and later covered with soil and sod. This cut-and-cover type is not adapted to all sections, however. In some places it is necessary to pierce through the hills, and then a tunnel was driven and lined with concrete. The tunnels are of the same horseshoe shape though somewhat smaller. There are about fourteen miles of these tunnels. Both the cut-and-cover aqueduct and the tunnels were constructed in the first instance to carry the full flow of five hundred million gallons. They have been in operation since 1915 and have not been materially disturbed since. They are built to endure.

The valleys intersecting the line of the aqueduct introduced a variation in the problem. Here, where the ancients would have carried the stream of water along an even grade on arches, the engineers designed inverted siphons. The stone or brick masonry, which was practically the only material available to the Roman engineers, would not withstand the bursting pressure of the water caused by making the channel dip down into the valleys; nor is concrete the best material for this purpose, so that the cut-and-cover type of aqueduct does not suit this condition. At the valley crossings, therefore, the cut-and-cover aqueduct terminates at either crest and the crossing is accomplished by means of steel pressure pipes laid just under the surface of the valley floor. These pipes have a circular steel shell

SIPHON PIPES UNDER CONSTRUCTION

These are of steel plates, riveted together, lined with cement mortar and covered with concrete. Between the freshly laid pipes is seen the embankment over the original pipe which has been flowing full of Catskill water since 1915. These pipes are a little larger than the first London tubes under the Thames, and a railway carriage could easily be accommodated inside

THE WATER TAKES AN AIRING—THE ASHOKAN AËRATOR

This beautiful scene conveys an impression more of a magnificent park with superb adornments of water and stone than of an engineering structure. Beyond the aërator is the screen chamber, while in the middle of the picture is seen the beginning of the aqueduct, here in cut-and-cover section

from nine to eleven feet in diameter and are encased in concrete, over which the sodded embankment is formed. Finally, the crossings under the Hudson and under several of the larger valleys are of the pressure tunnel type, which means that they were bored through solid rock well under the valley bottoms. These low-lying, concrete-lined pressure tunnels are of circular section.

SAFEGUARDING THE WATER

But what about natural causes—earthquake or flood—interrupting the aqueduct water traffic? In 1663 the valley of the Hudson was shaken by an earthquake so severe that the river overflowed and crops were ruined. The destructive forces occasionally unloosed by Nature and the occasional malicious frenzies of man must alike be reckoned with. In a close-up view this aqueduct looks like a pretty substantial structure; but on the map it is only an extremely tenuous artery stretching from clear up in the mountains to the canyons of Gotham. Consequently a series of storage reservoirs is provided which insures a supply to the city over a considerable period even in the event of interruption of the aqueduct flow.

After the waters impounded behind the massive Olive Bridge Dam in the Catskills are let through the gates of Ashokan into the aqueduct, we next see them as they pour over the inlet weir at Kensico. This capacious basin, formed by the Kensico Dam, which stretches across the Bronx River valley just above the historic city of White Plains, holds a supply of nearly thirty billion gallons, which it would take the consumption of two months to exhaust. The dam, finished in 1915, is one of the world's notable masonry structures, with a maximum height of 307 feet, built of cyclopean concrete (nearly a million barrels of Portland cement went into it) and faced with rough-hewn granite that gives it an imposing appearance appropriate to its important function. On pleasant holidays and week-ends many thousands of motorists visit this great structure and admire its splendid proportions and pleasing architecture. Nor is the dam all that repays one for a visit to Kensico, for, besides the various views of a fine expanse of clear water and wooded shore, the aërator with its sixteen hundred closely spaced nozzles spraying their fountains in iridescent, feathery foam over three acres of aquatic playground is an enlivening picture. Finally, as one motors north, toward the old Croton Reservoir with

THE GREAT ASHOKAN RESERVOIR

Across the middle of the picture the dividing weir between the two basins carries the concrete arch viaduct in a shining straight path sharply contrasting with the dark bulk of the mountains behind. In the center of the view is the upper gate chamber, and to the right the lower gate chamber, in front of which (just to the right of this view) is the aërator

its grand barrier of hewn stone, or toward the Catskills themselves to visit the source of this mighty spread of water, one passes over the beautiful concrete Rye Outlet bridge, whose five graceful arches cast a reflection in the calm, clear surface that is worth a pause to contemplate.

Fifteen miles nearer to the city and just north of the line that separates Yonkers from the Bronx is the Hill View Reservoir, located on high ground, from which one gets a view of the Palisades across the river. It is a small, uncovered, artificial reservoir that holds about two days' supply and is known as an equalizing reservoir, because its storage covers the fluctuations in demand through the day and permits the uninterrupted full flow through the aqueduct to that point. A vertical shaft forms the outlet, and connects with the upper end of the long City Tunnel.

UNDER SUBWAY, SKYSCRAPER AND HARBOR

It may be presumed that few of the hurrying scurrying millions that throng the streets and crowd the subways of New York know of the existence of the tunnel cored out of the solid rock far beneath them. It bores along through the Fordham gneiss which underlies the Bronx and dips down deeply to burrow under the Harlem River. Under most of the length of Manhattan the tunnel, with a diameter of thirteen feet or a little more, lies at a depth of two hundred to two hundred and fifty feet below the pavement. At Union Square, however, the level is abruptly dropped and the tunnel continues at the great depth of over seven hundred feet until it has passed under the mass of masonry and steel that comprises the lower skyscraper district and under the East River to Brooklyn, where the tunnel divides, one tube to go to the Borough of Queens, the other to cross under the Narrows to the Silver Lake Reservoir on Staten Island, the latter reservoir being the southern terminus of the water line which we have been tracing down from the Catskills.

The crossing of the Narrows was effected quite differently from the crossing of the Hudson at Storm King Mountain. First there went a dredge boat that reached down its clam-shell buckets to the ocean bottom and dug a deep, under-water trench. Then went a pipe-laying barge that, as it went, towed along a curving steel bridge with one end projecting up in an arc above the surface and the other end dragging along the

Keystone View

A PART OF THE GREAT DAM

This close-up view of the Ashokan Dam gives some idea of the magnitude of the undertaking. Observe the three figures in the picture: one at the bottom, another up the side to the left, and the third at the very top. The total length of the main Ashokan Dam is 4,650 feet and it holds back a lake twelve miles long. This reservoir has a water surface of 8,180 acres and an available capacity of 128,000,000,000 gallons, a quantity sufficiently great to cover all of Manhattan Island to a depth of thirty feet from 110th Street down

bottom of the trench. A thirty-six-inch steel pipe with flexible joints was put together on this bridge and permitted to slip down its length to the bottom of the trench, there to remain as the bridge was dragged along from under it. Then the trench was filled in to cover the pipe against harm from anchors or scour.

This account of the sensational achievement of the great New York aqueduct may fitly be concluded by a brief description of the Shandaken Tunnel, which for length has no equal in any other country of the world. This tunnel, over eighteen miles in length, receives the water of the Schoharie Creek impounded by the Gilboa Dam and carries it under the mountain peaks that mark the divide between the Schoharie and the Esopus, to pour it into the latter stream. Through alternate layers of blue and gray sandstone and red and green shale this horseshoe-shaped tube was pierced at depths varying up to twenty-two hundred feet. As in the case of the City Tunnel, the method employed was that of sinking a number of shafts along the line of the projected tunnel and boring both ways from the bottoms of the shafts.

INSPECTING A SUBMARINE AQUEDUCT

A diver goes down to examine the joints in the freshly laid aqueduct pipe that runs under New York Bay

One needs to visit this mountain country in the winter to appreciate the difficulty attending such extensive operations, which must of course be continued the year around. The snow drifts into the deep valleys and covers the roads so that they are impassable for months at a time.

After a shaft was down to the required level the tunneling was started. Rock drills were set to work, a battery of them being mounted on a pair of vertical shafts, so that the whole section could be drilled at one time. Behind the drills and the dynamite came the mucking machines, weird-looking monsters crawling along through the murky cavern inch by inch. One of these machines, operated by a twenty-horse-power motor, shoveled the broken rock or muck from in front of it and threw it onto an endless belt that carried it to the rear, where it fell into muck cars. In two minutes a car would be filled and started toward the shaft. Another more spectacular machine gathered up the blasted rock with its capacious shovel and tossed its burden—a quarter ton or so of muck—back over its sturdy iron body so that it would fall into the cars in the rear.

The headings of the tunnels, after being driven a mile or two from the several shafts, met within a few inches, thanks to the accuracy of the surveying. It was a great day when the eighteen miles of this tunnel were all dug and the last diaphragm of rock remained to be blasted out to the accompaniment of the ceremony that properly marked this important "holin' through." This was in the spring of 1922.

The inlet to this tunnel (which has throughout its length a concrete lining), is located on the left bank of the Schoharie, and above it, solidly planted in the rock, there has been constructed of the local bluestone a gatehouse of imposing proportions and severely plain architecture that accords well with the early traditions of this Rip Van Winkle country, for we are here right in the heart of the Catskills.

✣ ✣ ✣

And so comes the Catskill Mountain water, miles down, and under the Hudson, to relieve the thirst of New York City—and then, under the Narrows of the Bay, to the residents of Staten Island.

COMPLETING THE HUDSON RIVER TUNNEL, 1912

Mayor Gaynor switched on the electric current to blast the remaining section of rock between the headings which had been bored out from the two river banks. John R. Freeman, at the left, may be regarded as the father of the Catskill Water Supply. He has been consulting engineer from the very first. Next to Mr. Freeman is Board of Water Supply Commissioner Strauss, and between the latter and the orderly is seen Chief Engineer J. Waldo Smith. At the right is Commissioner Galvin. This "holin' through" was accomplished January 30, 1912

LAYING PIPE ACROSS THE NARROWS, NEW YORK BAY

The pipe was put together on a curved skid which extended to the bottom of the bay. The barge dragged the skid along the bottom, as the pipe was joined up, and out from under the pipe, which remained on the bottom in a trench dredged for it

THE SOUTHERNMOST END OF THE AQUEDUCT

Here, 160 miles from its source, is Catskill Mountain water among the hills of Staten Island, in Silver Lake Reservior

From a photograph of an old print

TRAVEL ON THE ERIE CANAL A HUNDRED YEARS AGO (1825)

A CENTURY OF CANALS

BY RICHARD DEAN

JUST one hundred years ago the Erie Canal was finished, and transportation of passengers and freight by American inland waterways began its day.

The methods of travel in those old days was leisurely and slow. Back in the eighteen thirties and forties it was quite the thing to go for a tour by canal boat. It was much preferred by some to "coaching it" on the dusty highway. Moreover, had you lived in those picturesque days, you would have considered the canal trip rapid and luxurious. You would have reserved accommodations a week in advance, packed your telescope bag and hurried down to the landing well before the flat-bottomed craft's arrival in town. You would have worn, in one case or the other, your most becoming crinoline and poke bonnet or your best frock suit, boots and beaver hat, and, with relative ease and comfort, in a chair on the deck, would have watched the country roll past at the rate of fifteen miles *a day*.

Here and there, for short distances, the boat traveled faster. The gruff, weather-stained boatman, complacently biting off a great chunk of tobacco, called occasionally to the barefoot boy on the towpath to whip up the horses to the sensational speed of six miles an hour. You would have held fast to your hat and breathed deeply of the rush of air from the meadows.

But after a mile or two the prospective President of the United States, short of breath and flinching from the briers on the towpath, would let the panting chargers settle down to a walk again; and so, if you cared to leap four or five feet from the deck to the shore and did not mind a short dog-trot to catch up with the boat, you could have gathered walnuts and late daisies at the edge of the woods. When you reached the locks, for the tedious operation of raising or lowering the boat to the next level, you might have had an hour or more for a picnic. In the small, struggling towns where the arrival was a regularly scheduled event you could have seen all the sights two or three times and even gone for a buggy ride before the incoming freight had been discharged and the outgoing freight taken aboard.

The meals, balancing in freshness what they lacked in style, came from the stove in the rough after cabin, cooked by the boatman's wife, whose red gingham Mother Hubbard and other odds and ends of the washing fluttered on a rope near the door. For supper, on the checked tablecloth, you would have had home-cured ham and newly laid eggs with vegetables that the farmers had gathered in the morning and carried down to the canal.

The sleeping quarters in the front cabin, with the men on one side of the curtain and the women on the other, would have been adequate, although you might have laughed at the funny bunks into which you climbed. On crowded nights you had to draw lots to

SCENE ON THE BARGE CANAL

Coal barges owned by the U. S. Navy Department traveling from the Great Lakes to New York City via the barge canal. A barge of this size carries 2,000 tons of coal

see who would sleep on the table. Morning etiquette prescribed that you dip a basin of water from the canal to make your toilet. If you had forgotten your comb there was one on the chain next to the roller towel. You attained an appetite for breakfast by walking briskly along the towpath.

One of the most graphic of Charles Dickens' pictures of American life in 1842 is a canal-boat journey described in his "American Notes." He had a poor time, for the weather was bad; yet he found much to commend as well as to criticize. Having learned the routine of life on a canal boat, including a speedy ducking of his head when the boatman called "low bridge," he enthused over the scenery and marveled at the engineering skill that conceived and executed the early American canal system.

Dickens had come to America at about the time that canal construction had reached its height. In 1840 the United States had five thousand miles of canals, a system providing intercommunication for thirty-two states. Passenger travel was incidental to the freight carried on these waterways. The eastern country, particularly, owes its basic prosperity to this old-time method of commerce.

The ancients were well skilled in canal construction. The Egyptians, we have reason to believe, had canals three thousand years before Tutankhamen. The Chaldeans, the Chinese and the Hindoos had them hundreds of years before the Christian Era. The Egyptians anticipated the Suez Canal by building a waterway from the Nile to the Red Sea, described by Herodotus in 400 B. C. The Romans linked the Rhone and the Tiber with the ocean. Charlemagne joined the upper Rhine and the Danube. Canal locks, the invention of which is credited to both the Dutch and the Italians, helped European canal building greatly during the fifteenth century.

European canal successes fresh in their minds, the Puritans had little more than established themselves at Plymouth before they considered such an enterprise to reduce the hazards of passage around Cape Cod. The Indians had found a way to escape the dangers by dragging their canoes across the sand from Buzzard's Bay to Barnstable Bay; so it was that the Puritans, under Miles Standish, as early as 1725—precisely two hundred years ago—developed the idea and began the agitation for what now is the Cape Cod Canal, providing a sheltered waterway from New York City to Boston.

But another hundred years passed before America saw the completion of its first really great canal project. The canals built

Photo by Gordon P. Gleason, Albany, N. Y.

GOING THROUGH A LOCK ON THE BARGE CANAL

The barge being towed is one hundred and fifty feet long and thirty-one feet wide. It has a draft of ten feet

in Colonial days and in the first few years of the Republic, fostered by Washington among others, faded into relative unimportance with the realization of the Erie Canal.

The turmoil that led up to the completion of De Witt Clinton's project was stormy indeed. Clinton's political rivals characterized him as a harebrained visionary; and they ridiculed him right and left, even bursting into a rather lame rhyme:

Oh, a ditch he would dig from the lakes to the sea,
The eighth of the world's matchless wonders to be.
Good land! How absurd! But why should you grin?
It will do to bury its mad author in.

The fight over "Clinton's Ditch" made Clinton the governor of New York and, in office, in 1817, he devoted all his energy to digging the canal, a ribbon four feet deep and twenty-eight feet wide at the bottom and extending 350 miles through forest and swamp from the Great Lakes to the Hudson. The work was so slow and expensive that the $5,000,000 originally appropriated soon was exhausted, which gave Clinton's enemies reason to cry that he was bankrupting the state. He won reëlection for a second term, but, two years later, when the canal still was unfinished, his political foes triumphed at the polls and he was thrown out of office. In disgrace, he also was ousted as chairman of the canal commission.

Ill fortune, however, soon took wings. Those sections of the canal that had been completed had been so beneficial to the country through which they passed that the people, with a change of heart, returned Clinton to the governorship; it was in the next year, 1825, that he completed the canal.

Clinton himself, with a party of state dignitaries, made the initial voyage from Buffalo to New York City aboard the canal boat *Seneca Chief*. All along the course of the canal the arrival of the boat signaled a holiday. The booming of cannon and the ringing of bells greeted the ears of the triumphant builder as his flag-adorned craft glided gracefully through the rolling country into the towns on the route. At Albany a fleet of river steamboats came up as a pompous escort, to remain close by for a magnificent entry into New York City.

New York, ever ready, even in those early days, for an excuse to celebrate, put on holiday garb and great crowds with banners of red, white and blue lined the banks of the Hudson to greet the *Seneca Chief;* the entertainment of Clinton, with feasts and torchlight processions, went on for a week or more. To the people of a hundred years ago the completion of the Erie Canal was fully as remarkable an engineering accomplishment as the Panama Canal is to us.

The Erie Canal, with its series of locks

stepping up the 500-foot difference in the levels of Lake Erie at Buffalo and the Hudson River at Albany, reflected instant profit to the state of New York. Freight rates dropped to almost a fourth; undreamed-of markets were opened. Flour that had cost $15 a barrel in New York City was to be had at $4. The tolls that the canal boatmen willingly paid restored to the state treasury within ten years all that Clinton had spent in digging the "ditch."

Instantly a cry went up everywhere for additional canals. Not only New York but many other states began costly building programs within the next twenty years. Some of the canals really were worth while; others were useless; a few were nothing more than an opportunity for graft.

To the railroads, obviously, goes the responsibility for the abandoning of all but a few of the more important canals in the country, with a consequent loss of more than a hundred million dollars spent in their construction. For the most part, on those canals that have survived, the old towline and the barefoot boy with the horses and mules have been replaced by sputtering tugs drawing strings of cargo barges, as may be seen to-day in the New York barge canals.

Few persons, even in New York State, realize the magnitude of the New York barge canal enterprise. These modern waterways differ from the old canals in as many essentials as do present-day locomotives from the old. The system, comprising sections of the Erie, the Champlain, the Oswego, the Cayuga and the Seneca canals, is linked up to full advantage with canalized streams and lakes. In every way they are considered the best designed and most modern canals in the world. State-owned, they are the medium by which vast quantities of grain, coal and other essential commodities are transferred between the Great Lakes and the sea.

Instead of being four feet deep the New York barge canals are twelve; instead of twenty-eight feet wide at the bottom they are seventy-five feet wide. They are navigated by steam-driven vessels with a cargo capacity of 2,800 tons. Five of the barges will carry as much as the largest of the vessels navigating the Great Lakes. The cost of the barge canals to the state of New York has been, to date, $167,000,000, and improvements still are in progress. The enterprise had its beginning when the people voted an amendment to the state constitution in 1903.

Naturally enough the barge canals are an issue in New York State politics, with factions for and against, just as there are factions for and against the other canals in the country. The dispute over the relative advantages of rail and canal transportation—begun when the railroads really got under way and canals fell into disuse generally—has gone forward without much interruption and without much prospect of early decision. Like many other questions it appears to be an issue of economics applied locally, considering costs of transportation and maintenance of way, character of freight for shipment and—since the money must come from their treasuries—the benefits that may go to the states and nation.

Photo by Gordon P. Gleason, Albany, N. Y.

THE OLD AND THE NEW—OLD ERIE BOATS ON THE BARGE CANAL

Only about two hundred of these old boats are left, and these will soon be displaced by modern, standardized barges of concrete or steel construction

GERRIT A. BENEKER

INTERPRETER OF THE DAY'S WORK

ILLUSTRATED WITH REPRODUCTIONS OF PAINTINGS BY MR. BENEKER

The Editor insists that I write this myself and make it biographical. What is written about a fellow after his voice is silenced is often far from what the voice would have said for itself—and so I tell my own story here. *G. A. B.*

IF HEREDITY is an influence upon life, then let it be known that my forebears were hard-working people. He for whom I am named was a contractor in Holland, who, having lost his all in a government contract, became discouraged and came to America in 1868, settling in Grand Rapids, Mich., where he continued his carpenter trade until past seventy years of age.

Photo from Standford Studio, Cleveland

GERRIT A. BENEKER

My great-grandfather on my mother's side was a "boss" on the dikes of Holland. He came to America in 1847 and settled in Holland, Mich., and later in Grand Rapids, where he built stone foundations for bridges. He left "the old country" for the same reasons and under the same conditions that the Pilgrims left Scrooby prior to 1620.

My father, at the early age of twelve, was about to go to The Hague to study art when suddenly he found himself passing through the gates at Castle Garden, a "green Dutch boy," and had to go to work. But the seed that was in him found expression in his son.

Each time I pass a milestone on the road of life I am sure to hear from my mother of that memorable night in January, the 26th, 1882, when in the midst of a violent thunderstorm and the raging fire of the old stave factory I became her first-born. The ten dollars for the doctor was under her pillow.

As a child I must have been always drawing pictures, for whenever I visit the old home town the relatives trot out my crude pictures of battles, ships and trains. I remember using Father's box of French water colors which he had as a boy, and when I was ten I received a new box of colors from Grandfather Steketee.

I managed to graduate from high school, but largely because I had to do fair work in order to play football, throw the hammer and be "south-paw" pitcher on the baseball team, although my teachers often told me that I would know my lessons better if I did not draw their pictures so often. A year or more before I graduated I had made up my mind to be an artist, and, while Father never discouraged me, he often told me how most artists starved in a garret and reminded me of my name, "Gerrit," although I was always called "Harry"—an Americanization of the good old Dutch name.

However, I made a bargain with Father: I was to earn my tuition for a year at the Chicago Art Institute if he would pay my board. So I pitched my last ball game and the next day went to work learning to stick and cull lumber ten hours a day for seven dollars a week at the furniture factory of John Widdicomb. I also piled tanbark and blistered my back under the hot August sun. Hard work? Yes, but valuable experience. As we sat over our dinner pails at noon I heard men talk about government ownership of the factory and how they would work three hours a day and be paid in food, clothing and lodging. They never thought

of how they would occupy their leisure time. They watched the clock and worked hard when the boss was around, and took it easier when he wasn't. One day Mr. Widdicomb sent for me and told me that if I would stay he would make a foreman out of me in six months, and so on up the ladder to become a real furniture man. When I told him of my purpose in life he replied that there would always be a job for me whenever I wished to come back. I spent a second summer in the factory; also, I found out what was the matter with most men: they had no incentive beyond the job. I had, and I worked the harder for that incentive, Art—and the girl who was waiting.

I landed at the Art Students' League in New York in October, 1903. In February, 1905, I won a $200 prize offered by the "New York Herald" for an Easter picture, and thought the road to success was now open. But not a publisher would give me a commission on the strength of the prize picture. With the original under my arm I stood in Fifth Avenue and watched a "roughneck" mount a girder and ride it fearlessly to the top of a new skyscraper. It thrilled me. Before a week had passed I had finished a black and white oil of what I had seen, and the first magazine that saw it, "Leslie's Weekly," bought it. Then followed other magazine work and a calendar picture. By this time I had saved $400 and went back to Michigan for my girl. A few weeks later we stood together in New York before the original of the calendar painting as it hung in the National Academy. Then followed covers in full color for the "Scientific American" which necessitated industrial research. I climbed over locomotives, into excavations and aqueducts, was on the new Manhattan Bridge at least once a week all the time it was building. I sat by the day in Bliss' foundry and the crucible steel works, watching the fire worshipers pour molten metal; and when I went through the steel mills of Homestead, Youngstown and Gary I was so thrilled that I vowed some day I would have a studio in a steel mill. Fourteen years later, when least expected, this dream came true. Meantime I wished to improve my color, so my wife and I made a bargain that we would move to Provincetown, Mass., for an indefinite period to pursue this "butterfly" called Art. When the nest egg got down to a certain amount we would go back to New York and do illustrations. We had one child then; we have four now—but we have never had to go back to New York.

© By Gerrit A. Beneker

"MEN ARE SQUARE"

Painted as an expression of the mutual faith and trust between employers and employees. "In every man is the inherent desire to want to be square with his fellow men," says Mr. Beneker. "Smile at him and he will smile at you; frown upon him and he will frown at you; treat him square and he will come back square"

It was Charles Hawthorne who told me that there was no reason why I could not become a painter if I would give myself ten years of hard work. In Provincetown we could live cheaply. Half the time at least I could paint, while enough illustrating followed me to supply the larder. Through the long quiet winters of Cape Cod we lived on memories of symphony concerts and the operas. I had been curtain man at the Metropolitan Opera House for matinées. The wife sat high up in a dollar seat while I earned the dollar back of the curtain; and we both heard the music. I have heard forty-five different operas, some of them many times over. We grew in appreciation from "Faust" and "Rigoletto" to "Tristan," "Meistersinger" and the "Ring."

Then came the World War: where did I fit in? After some red tape I got to Washington on the construction of the war and navy buildings. The young officer in charge had vision; he gave me a studio on the job where some 3,500 men were doing a record performance in building. Every week some four hundred to five hundred men would quit to "blow in" what they had earned the

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"A MACHINIST"—William Barnett

He bored the first motor that ever went into a locomotive, at the Schenectady Works of the General Electric Company, some thirty-five years ago

previous week: this did not help the cause. I painted a series of posters that encouraged the workers to feel that they were backing the fighting men in France. Political appointment stood like a stone wall across my path and kept the posters from national circulation, and I broke under the suppressed desire to serve. But truth always wins—in time.

When the armistice was signed the pictorial division ceased to function, and the twelve Federal Reserve heads demanded a look-in on the publicity for the Victory Loan, since it was up to them to raise the six billions. They unanimously accepted my poster of the working man digging into his jeans to buy bonds, entitled "Sure! We'll Finish the Job." But four months before this was published my dream came true when the Hydraulic Steel Company of Cleveland built a studio for me close beside the tall factory chimney, the idea being to use art as an educational and spiritual force.

Here was the opportunity to paint not obvious posters but the kind of pictures that art museums might hang on their walls. We are constantly told that art should never preach or teach, and I will admit that any form of art which does so obviously is an inferior expression, but all forms of art—pictures, dramas, poems—preach and teach subconsciously, and our subconscious minds

By Gerrit A. Beneker "THE FOREMAN"—Dave Eichhorn of the Hydraulic Steel Company, Cleveland

A foreman's job is not an easy one. He gets pressure from those above, and sometimes resentment from those below. As a matter of fact, in great productive industries the pressure is all along the line, and the foreman's job is simply the place where pressure finds expression. A good foreman, looked up to by his men, is one among many. Dave is a leader of men: not a driver

influence our conscious minds and therefore our actions. But the portrait alone is not enough except to those few whose minds are habitually in the cosmic. Knowledge is acquired from two sources, the intellect and the emotions, and both are necessary. Science and philosophy feed the intellect, while art and religion feed the emotions. Some of us have realized that science and religion are two parallels leading to the same end, and, as philosophy is the handmaid of science, and as art has always been the handmaid of religion, why not let these two handmaids work together? Consciousness of life develops from the primitive to the simple and from the simple to self, which is man, the herd animal. Self-consciousness is what is holding back all of us from becoming what the Creator intended us to become. But if art and philosophy are to lead us from self-consciousness into the realm of cosmic consciousness it must be an art taking its inspiration from all that is beautiful, good and true in life as we find it to-day, and a philosophy based on present-day experience. Then will art be "The Servant in the House" in any kind of organization, domestic, civic, industrial, economic, social, national and international, uniting peoples in service for the common good.

This is a selling age, and just as surely as we may sell Victory Bonds and manufactured articles through pictures, so may we sell men to men and nations to nations; but we must

By Gerrit A. Beneker "MY HANDS ARE BLACK BUT MY HEART IS HYDRAULIC"

"Peggy" Hirsch was the first workman painted by Beneker at the plant of the Hydraulic Steel Company, in Cleveland. "Peggy's" boss, the traffic manager, did not want to let "Peggy" off to pose, saying, "He is worth any two truck drivers in Cleveland." Beneker painted him, however, and when "Peggy" took a look to see what the artist was doing he remarked with some surprise, "Well, if it don't look like me!" Then there was no driving "Peggy" away; he returned several times a day for a week with his fellow workers to look at that "thing that looked like him." When "Peggy" was introduced to the artist he gave him a real "black hand" shake, not stopping to wipe his greasy hands on his overalls. Hence the inspiration for the title

begin by selling man to himself first. This is what Emerson meant when he said: "There is higher work for art than the arts: nothing less than the creation of man, and nature is its end." And the "Sage of Concord" continued: "For the hand can never execute anything higher than the character can inspire." We are experiencing the reverse of this to-day. Until the age of the machine, man created the whole article himself and found joy in his work. What he produced we place in our museums and recognize as art. The job formed his character. Now man stands day after day before an "Iron Man," a machine, an organization of many brains, which does all the thinking, while man controls the power that operates it, his brain becoming more atrophied the while. Is it any wonder that he seeks for happiness outside the job, since he feels he cannot find it in the job? *Actually* he is creating, and the machine is his partner. He can learn through art the relative value of his work to the work of the world, and the

© By Gerrit A. Beneker

"THE INVENTOR"

Like the artist, a dreamer of dreams, this inventor started out with Edison in the days of the beginning. For thirty-seven years he has been patiently at his task, evolving switches, sockets, insulators, and for the past twelve years he has been "playing" with push buttons, until now he has a new one, universal in action, that will enable us all more easily to command power to serve us

interdependence of all of us upon each other.

The late Charles Steinmetz, in speaking of the development of electrical power from our running streams, said: "All this development of natural resources is absolutely useless unless, along with it, we develop the spiritual nature in man, in which all that is best in Art can help." Science comes from the word meaning "to know," art from the word meaning "to do." Science and art must advance together, helping each other.

The most important phase of all in industry and business is the application of art to the attitude which motivates life, to the spiritual consciousness of man.

The greatest of all arts is the art of living. The eternal stream of life flows on through the ages, and we are but trustees of it while we are here. What kind of trustees are we? Does the stream grow dark and muddy; do we hold the dark mirror up to life? "Know thyself!" exhorts Ruskin, "for through thyself only canst thou know God." In mankind "is the image of God painted, . . . is the law of God written, . . . is the promise of God revealed."

© By Gerrit A. Beneker

"AN ENGINEER"

When we consider the highly dignified and noble profession of engineering and what engineers have built—the railroads, the skyscrapers and bridges, the dams that harness our rivers and the huge machines—we must not overlook the fact that all this construction would have been in vain had not this little man engineered his shovel along with his brothers of the spade in preparing the ground for what the college engineers were going to do later. Beneker found him digging the sand from beneath a factory floor where the engineers would soon erect a huge "Iron Man of Industry"

© By Gerrit A. Beneker

"A MAN OF THE HILLS"

A neighbor of Mr. Beneker's in the hills of Truro, Mass. Among other things he raises fine melons and strawberries. Also he is a good carpenter and mason. He supports a wife, five sons and three daughters

OLD PROBABILITIES—FOR YEARS HE HAS FORECAST RAIN OR SHINE

The Story of Uncle Sam's Weather Bureau and the Personality Behind It, Called "Old Probs"

In the seventies of the last century the most famous personage in the United States was "Old Probabilities," otherwise known as "Old Probs." He enjoyed a species of celebrity for which there was no precedent. There had been men and women before his time whose names were household words, but there had never been anybody who addressed a daily message to the entire country every day in the year, and whose published remarks were eagerly awaited and earnestly scanned in practically every home. His theme was one of universal interest—the weather. His predictions were consulted by the farmer, in doubt about cutting his hay; the vessel master, anxious to dodge the storms; young America, planning a picnic or a baseball game. Not everybody put unlimited faith in Old Probs. Some made jokes about him, as people have done about weather forecasters ever since, but nobody ignored him. P. T. Barnum must have turned green with envy whenever he thought of the boundless publicity achieved by the man whose announcements were displayed daily on the first page of every newspaper in the land.

GENERAL ALBERT J. MYER—"OLD PROBABILITIES"

Many people who remember well the days when Old Probabilities was a national institution have forgotten his real name. It is, however, perpetuated in that of an important military post across the Potomac River from Washington—Fort Myer. Even at the zenith of his fame General Albert J. Myer was a somewhat shadowy personality to the vast majority of his fellow countrymen. In military and scientific circles he was a more tangible figure. He was well known to soldiers, both in this country and abroad, as the inventor of an ingenious system of military signaling. This system was inspired by the signaling methods of the Indians, which he had observed while serving in the West as an army surgeon. It was taken up by the government, and Myer was appointed the first chief signal officer and the head of a new branch of the army known as the Signal Corps. In this capacity he rendered brilliant service to his country during the Civil War.

Far-seeing men had for years advocated the establishment of a system of weather forecasts and storm warnings based on telegraphic reports of meteorological observations, and the idea had been proved feasible by the experience of foreign governments and by unofficial undertakings in this country, when, in 1870, Congress took the momentous step of inaugurating such a system. The work was entrusted to the Signal Corps. General Myer and the officers and men under him suddenly found themselves engaged in tasks having nothing to do with the art of war. A few civilian scientific men were engaged to assist them, but on the whole the soldier meteorologists performed their novel duties with wonderful success. The weather service remained under military control until 1890, when the present civilian Weather Bureau was established. "It is probable," the once familiar phrase of official weather prediction, has been superseded by one more formal and severe, "the indications are." "Old Probabilities" is succeeded by an organization comprising several hundred stations and a large corps of staff workers.

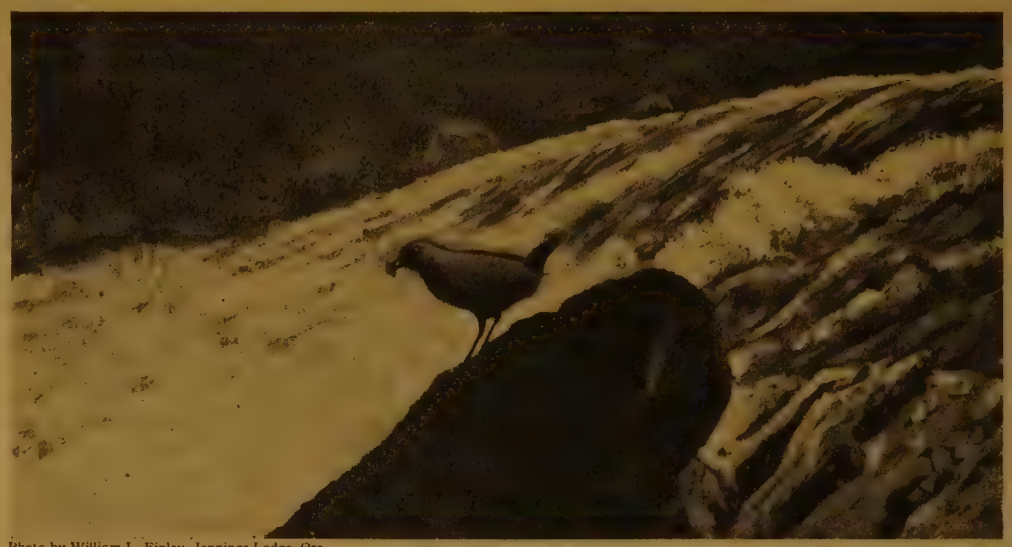


Photo by William L. Finley, Jennings Lodge, Ore.

A WATER OUZEL POISED ON A ROCK IN MIDSTREAM

THE WATER OUZEL

"The Mountain Stream's Own Darling"

The water ouzel—called also the water thrush and the American dipper—has a blithe and buoyant attitude toward life that makes friends for him the world over. Chunky and robust as a robin, he wears a waterproof cape of slaty-black, a muffler and cap of chocolate brown and leggings of yellow. His eyelids are touched with white and his eager bill is black. He is credited with possessing a third eyelid, an insurance against injury on his watery expeditions. Under his waterproof cape he wears another coat of oily down, after the fashion of typical water birds, though he is, technically speaking, a land bird, though *not* a landlubber. He is "the humming bird of blooming waters, loving rocky ripple slopes and sheets of foam, as a bee loves flowers—as a lark loves sunshine and meadows."

The water ouzel of North America haunts the crystal mountain streams, the roaring cataracts and the foaming waterfalls of the Pacific coast. Particularly does he love the freedom of the streams of our national parks and forests. Dancing along the restless Merced, he charms tourists thronging through the Yosemite Valley. Curtsying on the banks of the brawling streams in Mt. Baker National Forest, Washington, he beguiles mountaineers. His funny little tail, short and perpendicular, bobs and jerks as he teeters on the rim of a rock and flirts boldly with passers-by—with cascade and sky—under the tolerant gaze of old Mother Nature.

To the accompaniment of rushing waters the water ouzel sings his lilting melodies regardless of the weather. "His music is that of the stream itself," said John Muir, who greatly loved the ouzel.

If this member of the tuneful thrush family travels at all, it is up and down his own mountain stream. When the snow and ice of the uplands drive him out, he follows the stream of his adoption to the lowlands until the weather permits him to return.

He is a diver of rare ability, having mastered the trick by plunging into the crystal water for his fare of periwinkles, mollusks, water beetles and larvæ of insects. No water is too swift for him. The wilder the stream, the merrier he.

In the realm of bird architecture there are few nests so original in construction as the water ouzel's. He usually builds it—a rough, round ball—under the veil of a cataract, in the cleft of a rock or in an overhanging tree. He roofs it with moss; then, to keep it green and growing, he becomes an animated sprinkler, dipping repeatedly into the stream, mounting the dome of his dwelling and shaking the water from his wings upon the verdant roof. He enters the nest by a side door. In this snug little dwelling his mate lays her eggs, white as foam.

SINGING AND BARKING SANDS

Sand Dunes and Beaches That Give Off Musical Sounds Under Friction

BY HARRIET GEITHMANN

A visitor to Kauai, a night's ride from Honolulu, is introduced without delay to the "Barking Sands," a golden knot of wind-blown dunes in the shadow of the opal-hewed cliffs of Polihale. The sands cry out in various cadences. In the wind they rustle like silk. Again, when someone slides down the sandy slopes, a sound is produced like the bark of dogs baying at the moon.

The Barking Sands of Kauai are a natural curiosity, a phenomenon in Mother Nature's bag of tricks that astonishes all that hear them. The weather must be dry for them to bark their best. Midsummer seems to be the ideal time for their sonorous reactions.

THE BARKING SANDS OF KAUAI, HAWAII
Sliding down these sand dunes one can hear the distinct "Woof! Woof!" of the sand dogs

The phenomenon of "singing sands" has been discovered on various beaches of England and Wales. On the Isle of Eigg in the Hebrides a stretch of snowy sands, near the cliffs of sandstone, has this strange musical quality.

In the dune region along the eastern shore of Lake Michigan sands sing under the feet with definite sound vibrations, both delightful and curious. The sound ceases a hundred feet from the last lap of the waves.

Thoreau stumbled upon singing sands in New Hampshire, southeast of the village of Manchester. He said the sound resembled the rubbing of a finger on wet glass.

At a spot on the coast of southern California religious devotees declare that a convent lies buried under the sand, for at the Angelus hour they hear the muffled tones of bells.

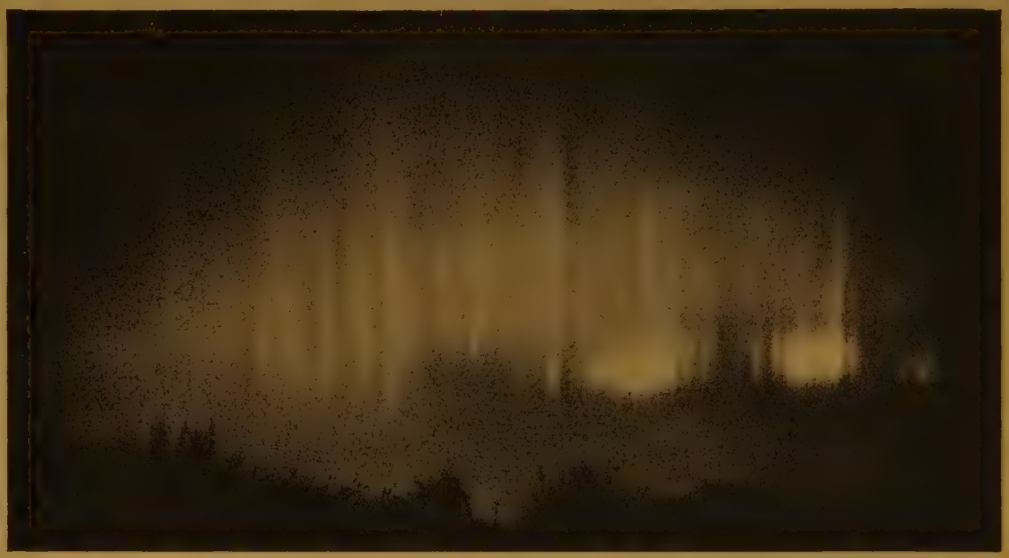
World-wide travelers and superstitious Arabs listen to the weird chanting of the sands at the foot of the "Mountain of the Bell," the famous Jebel Nagous of the Isthmus of Suez. When storms whip the steep slopes the sands protest their loudest. On fair days they give out tinkling notes. On windy days there is always a musical ripple. The beauty of the deep, organ notes of Jebel Nagous is proclaimed in the "Arabian Nights."

A paper bag is the best container of singing sands. When the sand is transported sound sometimes is retained for a long while. The sonorous quality is soon lost in a glass or metal vessel.

For over a thousand years the literature of the world has mentioned singing sands. Travelers and explorers have stumbled across this phenomenon along the beaches of the world. Marco Polo frequently referred to musical sands and the superstitions attached to them. For the last fifty years scientists have diligently studied the causes at work behind the phenomenon.

One investigator's explanation is that certain sandy stretches are bathed in waters containing various salts, including calcium and magnesium bicarbonates. When the water dries, the grains are coated with a film of salt, which under friction produces a sound comparable to the action of rosin on the bow of a violin.

Dr. H. Carrington Bolton believes that thin pellicles or films of air or gases, condensed upon the surface of the grains, during the gradual evaporation after a wetting, act as elastic cushions separating the grains. These cushions are capable of considerable vibration and volume of sound, produced after any quick disturbance of the sand.



THE GHOSTLY BEAMS OF THE "NORTHERN DAWN"

A typical display of aurora borealis, photographed in Norway by Prof. Störmer. The beams have sometimes been traced to an altitude of more than 450 miles above the earth, and are the highest visible phenomenon of our atmosphere

WHAT IS THE AURORA?

Science is Gathering Facts That May Solve the Mystery of the "Northern Lights"

BY C. F. TALMAN, U. S. Weather Bureau

Nothing in the wide range of Nature's fireworks is more impressive than the weird beauty of the aurora, especially to dwellers in regions remote from its usual haunts, who rarely see it in all its grandeur.

In the northern half of the United States the aurora is visible more often than most people suppose. Those who keep a lookout for it will frequently detect, on clear, moonless nights, a low-lying glow or a well-defined arch of pale pearly light over the northern horizon. When it takes the arched form the sky beneath looks dark and smoky, and this peculiar aspect of the sky may often be observed before the arch itself appears. In the more striking displays the arch may rise higher in the sky, shift from side to side and undergo various changes of form. Sometimes two or more parallel arches are seen. Another characteristic feature of a fine aurora is the appearance of beams or "streamers," which shoot up from the arch in great fanlike sheafs. These luminous beams are sometimes fixed in position, but more often they shift in ghostly procession across the sky. At times they shake with a tremulous motion, and again flashes or pulsations of light roll up toward the zenith. More wonderful forms are sometimes observed, even in our latitudes. The streamers may lengthen and converge toward a point south of the zenith to form a canopy of flame, known as the "corona." This occurred in the splendid displays of March, 1920, seen over a wide area of the United States. On that occasion, too, clusters of beams formed vast sweeping "draperies," and the whole sky was filled with gorgeously colored fire—yellow, green, pink and deep red.

The displays just mentioned gave rise to some startling specimens of "newspaper science." One of the least nonsensical explanations of the phenomenon offered was that it was due to the reflection of sunlight from the ice fields of the polar region, an explanation that was once entertained quite seriously by men of science.

Though there are still some unsolved

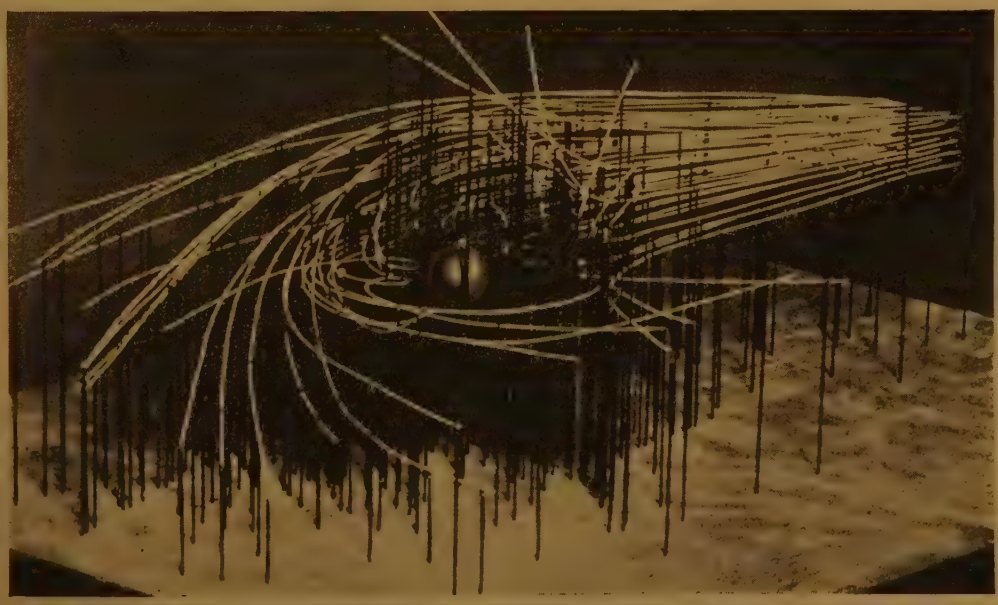
problems connected with the aurora, it is by no means the mysterious phenomenon that it was a generation ago. If you have ever seen the glowing discharge of electricity passing through a vacuum tube—such as a Crookes' tube, a mercury-vapor lamp, etc. —you have seen something very similar in character to the aurora. These tubes contain highly rarefied gases, and the upper atmosphere, in which the aurora occurs, likewise consists of gases in a state of extreme rarefication. The discharge in the vacuum tube is due to an artificial electric current. What takes the place of this current in the case of the aurora?

This question was long debated, but we now feel practically certain that the atmospheric gases are set aglow by streams of electrified particles sent out from the sun. It has long been known that the sun is subject to marked variations in activity. It has its quiescent periods, when few spots are seen on its surface and few "prominences" of incandescent gas shoot out from its disk. At other times it is in a state of violent turmoil. These changes, especially as revealed by "spottedness," run through a cycle that averages about eleven years from maximum to maximum and from minimum to minimum. A corresponding cycle has been found in the frequency of auroras. A maximum of sun spots generally coincides with a maximum of auroral displays; when spots are few, auroras are also rare.

The connection between sun spots and auroras is an old story, but the precise way in which the auroral discharge takes place under a bombardment of particles shot out from the sun has only been explained in comparatively recent years. The explanation is due especially to a Norwegian physicist, the late Prof. Kristian Birkeland.

Before we outline this explanation it should be stated that the aurora tends to form two belts encircling the polar regions of both hemispheres. The northern belt is the *aurora borealis* and the southern the *aurora australis*. These belts are sometimes narrow or reduced to mere fragments, while at other times they are so broad that they spread far over the temperate zones. These variations in size explain why the aurora, when visible in our latitudes, is generally seen only over the northern horizon, though it occasionally envelops the whole sky.

Why should the aurora form these belts? And why, if it is caused by discharges from the sun, should it be seen at all on the *night* side of the earth—the side turned away from the sun? The answers to both these questions depend upon the fact that the earth is a great magnet, and that, like other



ONE OF STÖRMER'S REMARKABLE MODELS

Showing the calculated paths of electrified particles from the sun entering the earth's magnetic field

magnets, it has the property of deflecting from a straight path an electrical discharge that occurs in its vicinity. Birkeland produced in his laboratory a miniature aurora, by suspending in a glass vessel, exhausted of air, a magnetized metal sphere representing the earth, and exposing it to a discharge of cathode rays. Such a sphere is known as a "terrella" (meaning "little earth"). The sphere was coated with a phosphorescent substance, which glowed under the discharge. This glow was found to be confined to two zones surrounding the poles of the magnet, and corresponding roughly to the auroral belts of the earth.

It remained for another Norwegian, Professor Carl Störmer, to work out by laborious mathematical calculations the actual spiral paths followed by the electrified solar particles when they approach the earth and come within the influence of its magnetic "field," and to show that many of these paths would swerve about in such a way as to produce an aurora on the side of our globe that is shrouded in night at the time. The results of these calculations, instead of being merely set down on paper, have been embodied by Störmer in a number of remarkable little models.

The same physicist has developed, since the year 1909, a wonderful system of studying the aurora by photography. By means of simultaneous photographs taken at two or more stations connected by telephone the actual distance and position in space of any feature of an auroral display can be determined. Störmer and his assistants have made thousands of photographic measurements of the altitude of the auroral arch and of the streamers. These show that the aurora rarely extends farther down into the earth's atmosphere than to an altitude of some fifty-four miles above the earth. The streamers frequently extend upward to a height of three hundred miles, and occasionally much higher. In the display of March, 1920, already mentioned, one streamer was photographed up to the enormous altitude of four hundred and seventy miles.

The spectrum of the aurora, which is comparatively easy to observe, ought to tell us something about the chemical composition of the upper atmosphere. The principal feature of the auroral spectrum, a bright yellowish-green line, has, however, proved something of an enigma. It has been attributed to a number of different elements by different authorities, some of whom have believed it to be due to a substance unknown to chemistry. At this writing the balance of probability seems to be in favor of ascribing it to a mixture of oxygen and helium.

THE AURORA REPRODUCED IN THE LABORATORY

Left: Magnified iron sphere, representing the earth, exposed in a vacuum to discharge of cathode rays. Note how the glow of the imitation aurora tends to form rings around the magnetic poles. Right: Part of a model, showing how the streams of electrified particles from the sun are supposed to be turned from a straight course on coming within the earth's magnetic field

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EVERY ARTICLE IN THIS PICTURE IS MADE OF WOOD OR OWES ITS ORIGIN TO WOOD

A MODEL WOODEN WEDDING ✣

A generation ago books had no place among wooden wedding presents, because the paper on which they were printed was, as a rule, made from rags. Those seen in our picture are the product of an age in which ninety per cent of all printing paper comes from wood pulp.

The young woman holds in her hands a pair of fiber silk stockings. The "artificial" silk now made by scientific methods from wood or cotton—mostly from wood—is as good for most purposes as the "real" silk obtained by a crude and cruel process from the cocoon of the silkworm. If it repeats the history of many other "imitations" due to modern chemistry it will soon be *better* than silkworm silk and will drive the latter out of the market.

The young man holds a phonograph record in his hand. It is true that these shiny black disks, popularly supposed to be made of rubber, do not consist wholly of wood, but a large proportion of them contain from sixty to eighty per cent of wood flour, and another common ingredient is wood charcoal.

As to the unopened parcels, we can only certify to the fact that they are wrapped and tied with products of the forest. Both paper and twine came from that versatile substance, wood pulp.

The other objects in the room are woodier than you might suppose. The rug on the floor was not woven of grass but of a "fiber" made from wood pulp.

The furniture is also of the "fiber" variety, in which reeds of twisted paper, of wood origin, are used in place of the ordinary reeds of commerce. Sometimes these paper reeds are stiffened chemically, and sometimes they have a core of wire.

The scrapbasket is made of a wood-pulp "board" and so are the walls of the room. The use of this pulp product in building walls came into prominence during the World War, when millions of feet of such "wall board" went into the construction of cantonments and other temporary buildings.

The young woman's sweater, like the drapery on the wall, is of fiber silk. As to the turpentine and wood alcohol used in the paints and varnishes, the tanbark that helped to make the young man's pair of shoes and—But we must stop somewhere.

Moral: Take care of the forests. They are taking care of *us*.

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THE MENTOR

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THE OPEN LETTER

WHEN we were preparing the story of John J. Audubon, "the man that made American birds famous," it did not occur to us that there were Audubons still living—direct descendants of the great Bird Friend. We thought of the name of Audubon simply as an historic one in bird lore. John J. Audubon died in 1851, and his monumental work on American birds has now become a rare set of volumes much sought after as a prize by book collectors. Aside from this great set of books, the name of Audubon has come to be associated in the minds of most of us with state societies engaged in the work of befriending birds and improving the affairs of the bird world.

It was, then, a pleasant surprise for us to find in our mail, a few days after the publication of the June Mentor, the following letter written by a granddaughter of John J. Audubon; it bears a message that will interest Mentor readers, especially those that love birds, and have come to venerate the name of Audubon:

Salem,
Washington County, N. Y.,
June 19, 1925.

Your article in The Mentor for June is of much interest to me, and I want to thank you for writing it; the pictures are lovely; the house has been so greatly altered that I should not recognize it. We left it in 1862; at that time there was no mansard roof, and it is, if I am not mistaken, the back of the house, the side next the river, that you have photographed. If so, then the steps have been changed, for when we lived there the piazza went down two steps to a rather large landing, from which two flights of stairs went down, one to the south and one to the north. I never go near it, and have not for many years, as I want to keep my old memories.

I am a *very* old woman, but I remember my grandfather perfectly, with his beautiful long white hair—and he taught us all to dance.

The portrait, of which we own the original, and it is now in our library, is very well reproduced. Your copy, I think, is taken from that in the Museum of Natural History, in New York, which once belonged to Mr. Lewis G. Morris.

Your paper is a most interesting sketch of a pure and noble life—and once more I thank you. Very truly yours,

M. R. AUDUBON.

We wrote to Miss Audubon expressing our pleasure in her letter, and asking her permission to share it with our readers. We give her reply:

Many thanks for yours of June 26th, which you are quite at liberty to publish if you wish to do so. I think personally it is a shabby little scrap. Perhaps I could write you a better one, but I don't know, because my "poor days" are now of such frequent occurrence.

When I was a girl I had a very handsome great-aunt, who was also very old, who used frequently to speak of the "curse of old age." My mother thought it very wicked of her—but now that I stand where she did, and realize how many losses and limitations come with old age, I feel more leniently towards my old aunt. It was much harder for her than for me, as she was for many years one of the leading beauties of New Orleans, while I was never anything to her but "that little dark child"—with three handsome sisters.

If I wrote The Mentor a letter every day for a month it would not pay for my pleasure in those superb eagles. I shall put your letter in my "Audubon books," which I began when I published "Audubon and His Journals" thirty years ago.

I am gratefully yours,
M. R. AUDUBON.

W. D. Moffat
Editor